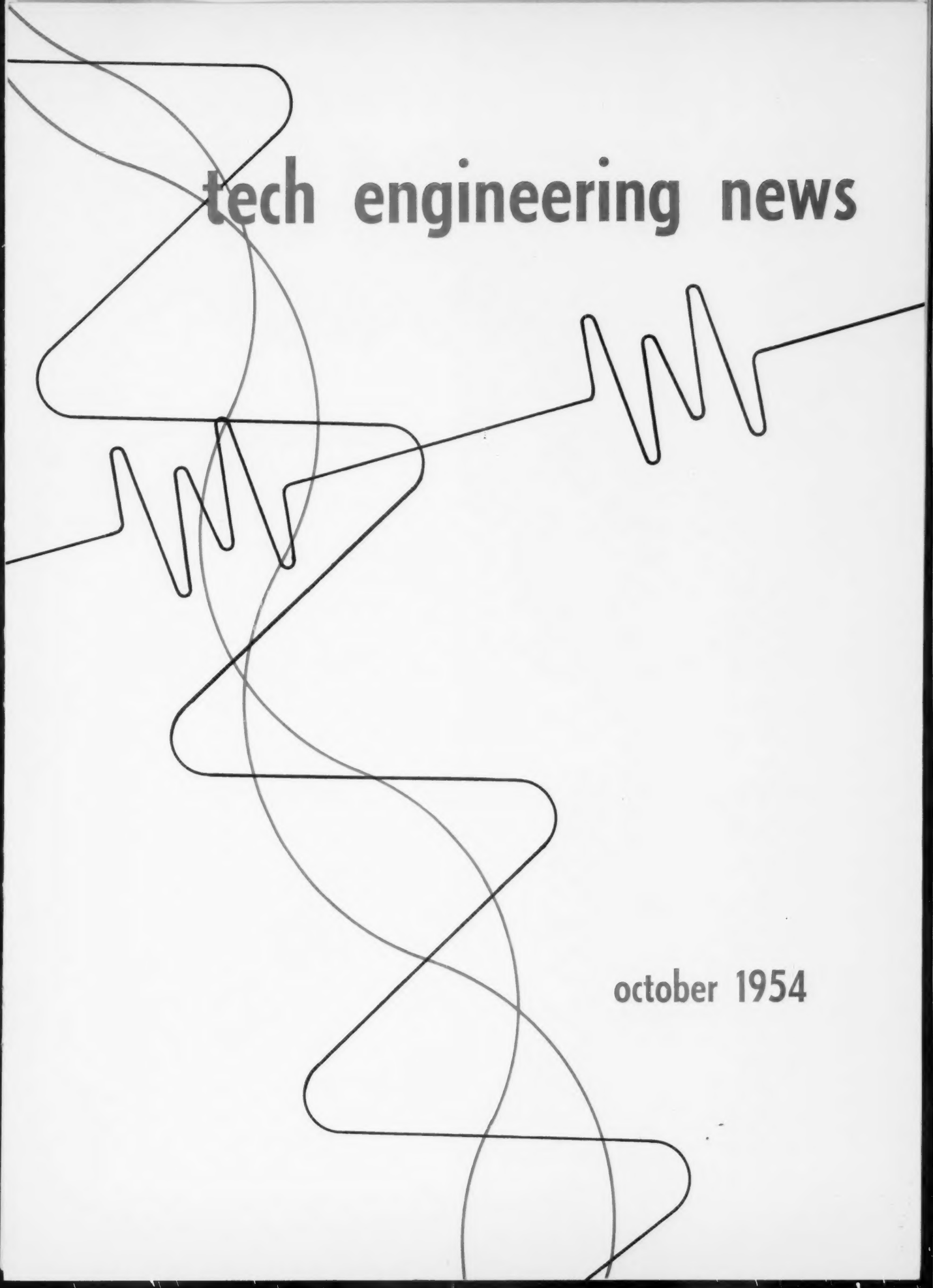
tech engineering news



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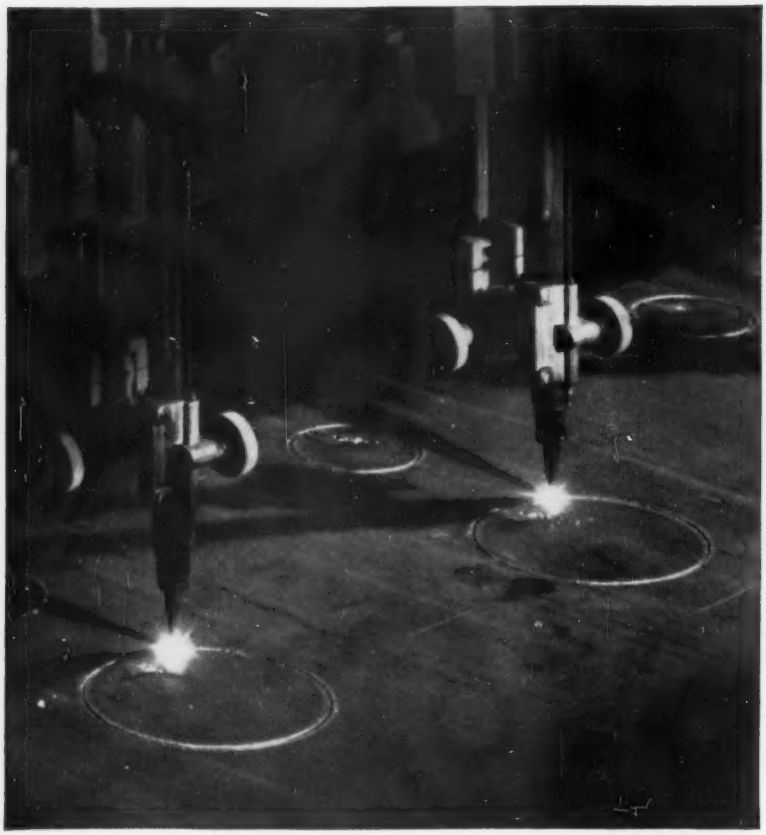

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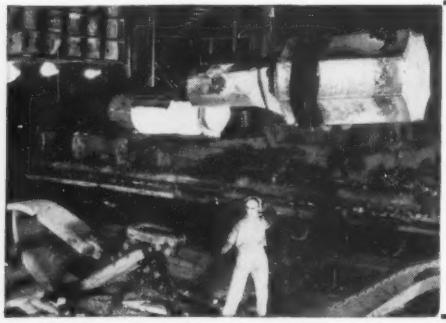

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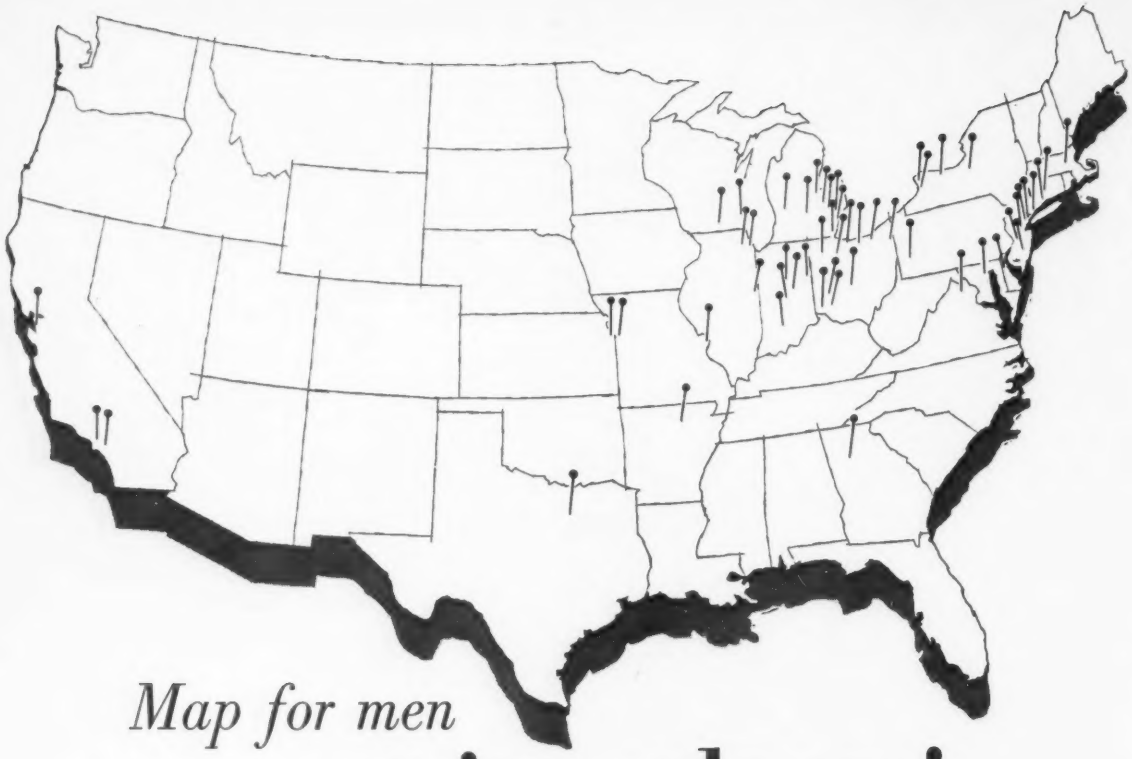

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Most of these machines were either completely or largely designed and developed by Western Electric engineers.

RESULTS: With skill built into the machines —with costly hand operations eliminated— this Western Electric mechanization program raised production of quartz crystals from a few thousand a year to nearly a million a month during the war years. This is just one of the many unusual jobs undertaken and solved by Western Electric engineers.

Quartz stones are cut into wafers on this diamond-edged saw, with orientation to optical axis controlled by fixture. This is just one of several types of machines designed and developed by Western Electric engineers to mechanize quartz cutting.

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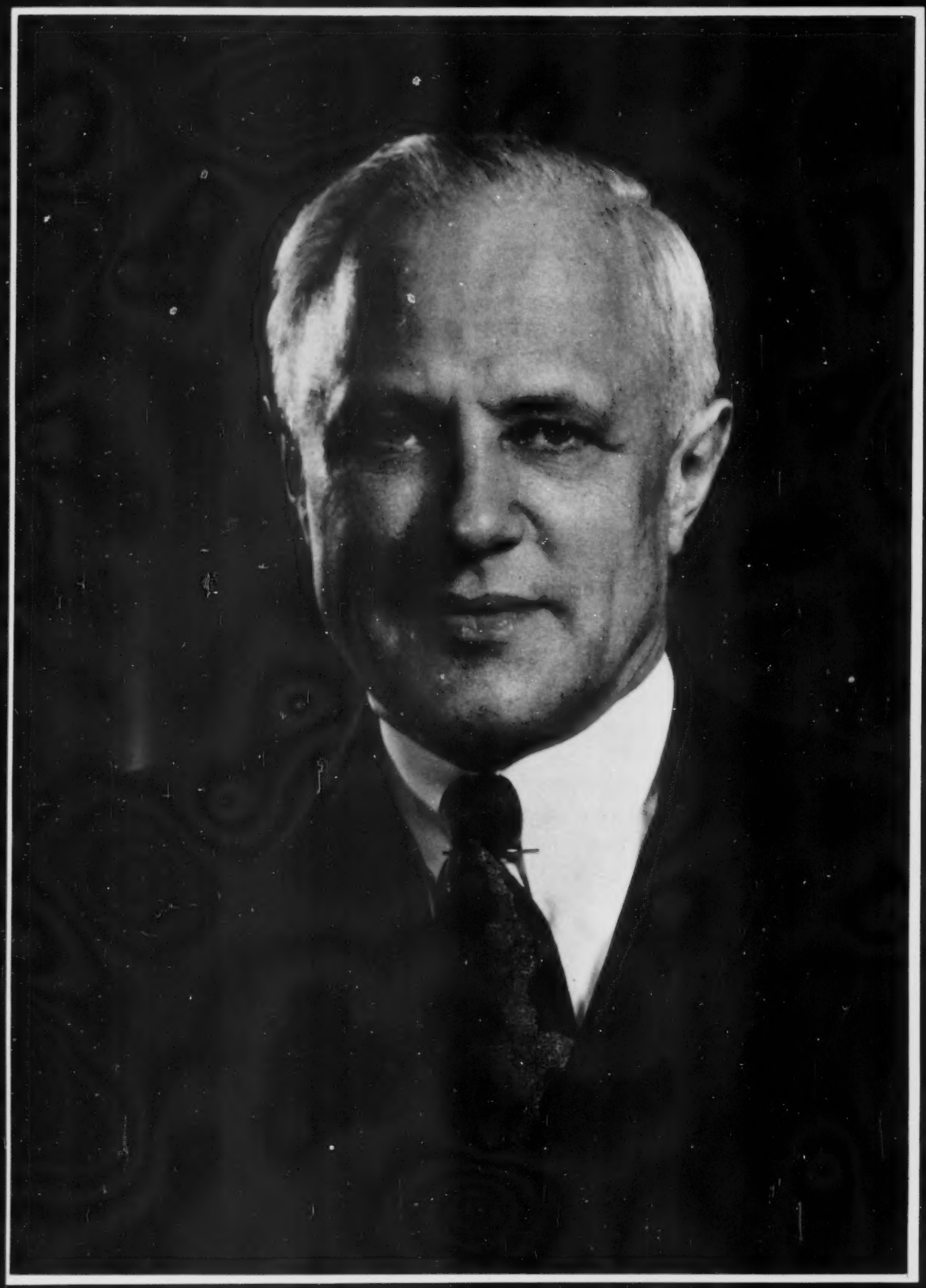

Dr. Karl Taylor Compton
1887 - 1954

tech engineering news

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FRONTISPIECE

Dr. Karl T. Compton . . . Scientist, Educator, Administrator

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THE ALUMINUM INDUSTRY WAS BORN ON SMALLMAN STREET

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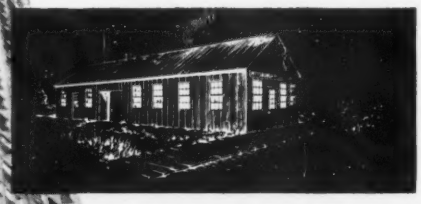
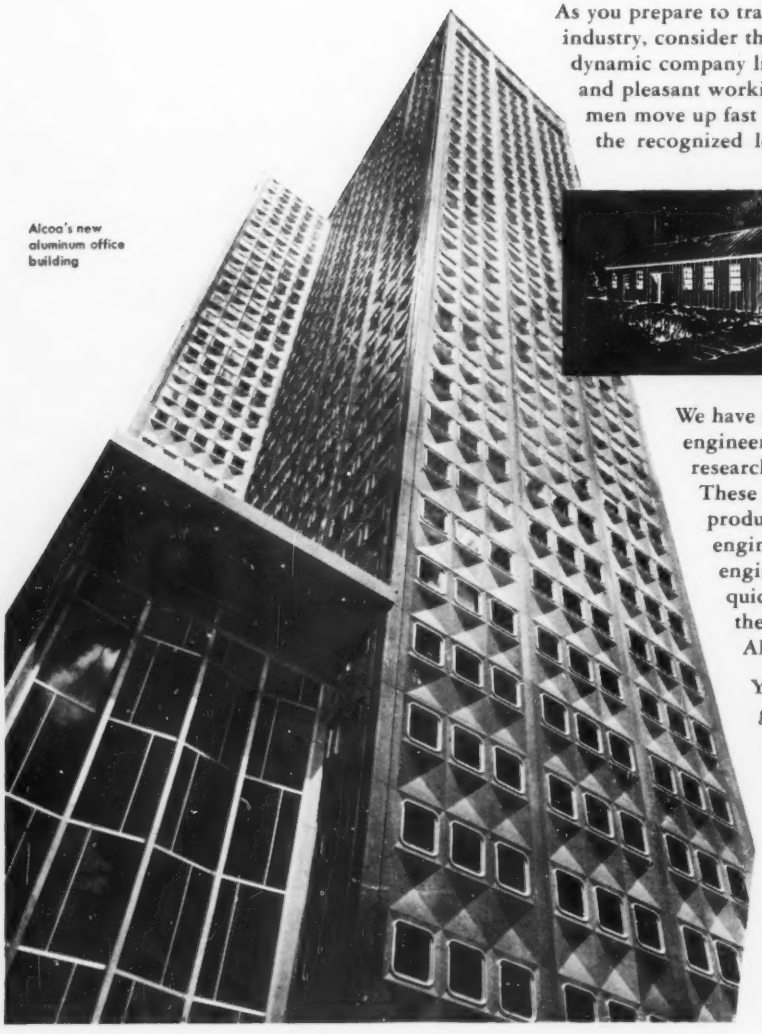


Alcoa's new aluminum office building



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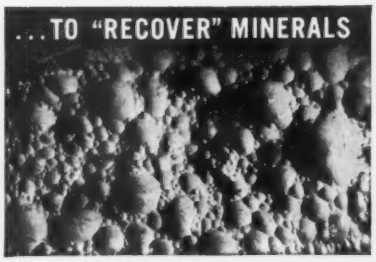

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it falleth as....

By Jay Stevens

I was in the office of General T. L. Brigham when the story broke. I'd been interviewing the General for the *El Paso World*, looking for a Sunday supplement story on the current doings of the First Cavalry Division. He and I had just hashed over some of the drastic changes in cavalry organization since the First came to Fort Bliss in 1852, when a group of officers charged into the office like the Light Brigade charging into the valley of death. All of them were visibly flustered. This in itself was unusual . . . I knew two of the men, and they weren't the type to fluster easily. One of my acquaintances, the Post Security Officer, looked at Brigham and said, "General, our radar has just tracked a formation of UFO's to ground up north."

Al Hackett, the Public Information Officer of Fort Bliss and a pretty good friend of mine, walked across the office. "I'm sorry you heard that, Jay," he said. "This isn't the kind of story we can have getting around. The public would panic in a minute." The PIO conferred for a few moments with the general, then addressed me again. "We may need a good objective newsman," he said. "Here's your choice. Walk out of here now with a wild rumor to print . . . a rumor we'll deny every step of the way. Or stick around, get the story, and sit on it until we give the release. What do you say?"

I said I'd sit.

A group of about 30 unidentified objects, flying saucers or what have you, had been sighted by radar, traveling at about 1500 m.p.h., and had been tracked to earth in the Jornada del Muerto, an arid New Mexico valley between El Paso and Albuquerque. Discouragingly close to White Sands Proving Grounds.

While the staff briefed the general, reports started flooding into his office. F-86's from Biggs Air Force Base were circling over Jornada del Muerto, radioing back to the base. They reported 33 grounded craft, of the traditional disk-like shape. One pilot reported movement on the ground beside one of the ships. Then there were no more jets circling over Jornada del Muetro.

No matter what his critics may say, Brigham is a fast man with an armored calvary division. Within half an hour he had two battalions of light tanks on the highway, followed by M-16 quad-mounted .50 calibre machine guns on tank chassis, 40 mm guns and a battalion of 90 mm antiaircraft artillery. Orders to close the El Paso-Albuquerque highway were issued at once; railroad travel was halted and airliners diverted from the area. Helicopters loaded with ground troops were dispatched to the area to clear out civilians, but the troops were ordered not to go near the strange craft. The ground force was ordered to set up a field headquarters in preparation for arrival of the high brass.

In this case the high brass included me. Brigham, his staff and I took off from Biggs Field at 3:30, and 45 minutes later landed on the highway a few miles south of Jornada del Muerto. We started hiking up a dirt road cut through the desert, and were met shortly by a jeep which had been parachuted to the helicopter troops. The Army doesn't do things half way. We jeeped to

the site of HQ, a bumpy ride of about five miles.

Headquarters was established in the lee of a small rise, about three-quarters of a mile from the nearest saucer. All the disks were in a shallow basin of the valley, rimmed on the west by low but jagged mountains and on the south by undulating hills. The Texas and Pacific Railroad tracks ran along the eastern side of the basin. The GI's gave us the lay of the land, and Hackett and I crawled up the hill to see if we could spot anything.

Three things caught my eye as I peered through the glasses from under a mesquite bush. First, directly in front of me was a large blob of metal, which had evidently fallen from quite a height. It appeared to have been melted into a single mess, a tremendous, misshapen cannonball . . . it also appeared to have been an F-86. Spread out over a wide area were the saucers, looking just as flying saucers should have looked. Grouped around one of the craft in the middle distance were about 25 man-sized shapes, moving about slowly. Hackett took one look at them and muttered to himself, "Good God Almighty!"

Several minutes of observation convinced me that the shapes were moving as a man would move if he were trying to walk while sealed inside a gunny-sack. Hackett got the same impression. It seemed that the figures, their shapes indiscernible, were covered by many layers of thick clothing, or clothing's equivalent.

Returning to HQ, we found Brigham and the brass discussing the disposition of these interlopers.

The big question mark was why the disk-denizens were here at all. If they were on a peaceful mission we couldn't afford to antagonize them, since they seemed heavily armed. If they were after a fight, we couldn't afford to let them get away. And in any case, we would probably run into some trouble eliminating them. While this discussion was dragging on, Security called for silence,

and we all heard the unmistakable sound of a distant diesel engine whistle.

The T and P local had somehow passed through Oro Grande without being flagged down. And there was nothing we could do to stop it from running within a quarter-mile of the saucers. Grabbing our glasses, we took off for the top of the hill. The train was batting along at about 80 miles per hour, roaring furiously down Jornada del Muerto when I first got the glasses focused on it. The locomotive, dragging a long string of passenger cars behind it, gave a derisive hoot of its whistle . . . and disappeared in a blob of molten glup. The entire train melted before our eyes, in the space of a second. Molten metal splashed down the roadbed in the direction of the train's travel, and, solidifying, rolled to a stop. The remains of train, passengers, crew and tracks lay, glowing a dull red, in the desert sunlight. One of the staff officers, silver eagles glinting on his shoulders, rolled over and was violently sick. The silence of the dead, and of the desert, returned to the scene.

At headquarters Brigham had one comment. "Let's blow hell out of those bastards."

Battalion commanders of the tank groups reported to headquarters by radio from the road, and received orders to deploy around the area occupied by the saucers, keeping out of sight and out of line of fire of the saucer-citizens. Artillery commanders were told to dig in the 90's back at the road, and to bring the light pieces up with the tanks.

As Brigham stepped outside his command post trailer to greet the first tank commander, a flash of light passed over the command post. A GI from the watch posted over the disks came running down to HQ, yelling that one of the monsters had just taken off. Half a minute later the radio operator came on the double to report that he had been cut off from White Sands in the middle of a message. And a minute after that we noticed a cloud of dense, swirling white smoke, or possibly steam, rising from out of the desert on the western side of the mountains. We knew, with no further evidence, that White Sands was gone.

"Open fire," Brigham said to his microphone.

The characteristic "whump" of 90 mm shells falling came to us from over the rise. We could see flashes of light, as the sunlight began to fail under a large bank of clouds. Hackett and I crawled up the hill to see what was happening. Nothing was. The 90 shells were being detonated far above their targets, and as far as we could see there were no shell fragments falling among the saucers. We ran back to HQ to check what type fuse the 90's were firing . . . a mis-set proximity fuse might explain what was happening. Brigham relayed our question, and got his answer . . . they were firing time-mechanical fuse, set to explode on contact. The saucer-men were detonating our shells prematurely. Artillery was useless. So, it stood to reason, bombs would be useless.

"Open fire and advance under fire cover," Brigham said into his mike, and the tanks began to move forward. We all realized that this was a desperation move, the last stalling move Brigham could make with the cards he held. There were more people, more lives in prospective target areas, than there were in our tank detachment, so we were buying time with GI lives.

As the tanks rolled into motion, spraying lead

and steel in their path. I felt a drop of rain on my face. This was impossible, I told myself. It doesn't rain in Jornada del Muerto. The place has an average yearly rainfall of about two inches, and that usually comes in one great downpour.

One of the tanks disappeared into a puddle of smoking lava.

The rain was definitely rain, though. It increased in intensity, falling faster. Big drops, I thought. This might be the big yearly rainstorm. The clouds were thick, and getting darker. The wind whipped up.

Another tank dissolved.

As the rain grew, promising a real desert drowner, a lookout on the crest of the hill stood up and waved his arms; I took off to see what was up.

The tanks were in close, much closer than the train had approached or than the two destroyed tanks had advanced. I noticed the group of figures clustered beside one of the saucers. Their clumsy, awkward clothing didn't seem as cumbersome as it had before. A close look through the glasses revealed that the suits were shredding, dissolving in the driving rainstorm. One of the figures clutched at what probably passed for its throat, staggered and fell. Another did the same; then the whole group was lying flat, motionless in the mud.

At a time like that you don't question fate. The GI lookout waved to HQ, and an artillery captain ran up the hill. On his signal the firing ceased. The tanks continued to bore in. By the time they reached the first saucer one of the others had taken off . . . then four others followed it. The remaining saucers stood dormant beside the heap of crumpled figures.

One of the escaping saucers wheeled overhead, and the entire basin, saucers, fallen spacemen and tanks, disintegrated in a whorl of steam.

The battle was over.

Hackett grinned at me over his half-finished Manhattan. "How does it feel to have a story like this and not be able to print it?" he asked.

"How would you feel if you had this whole room full of liquor," I waved my hand at the cocktail lounge, "and couldn't drink it?"

"Touche," he said. "Say, I got a report of sorts from the Division Chemical Officer today . . . He figures that, if the atmosphere of these saucer-men isn't like our air, their main liquid wouldn't be like water, either. For instance, say their system has *ethane instead of air, and acetone instead of water* . . . if you should happen to go there wearing a rayon suit, it would dissolve like sugar in coffee . . . you'd be left breathing pure ethane, and I don't think you'd last too awfully long. The same thing happened to them. According to our learned chemist, the water depolymerized their suits. Pfft.

"Also, the official word is that this story doesn't get printed. Probably not ever. You can imagine public reaction every time an unidentified flying object was sighted, if people knew what had happened here."

"Yeah," I said. "But I still have a question to ask. Do you know why that place was called Jornada del Muerto?"

"Shoot."

"When the old Spanish conquistadores came through this country, they had a damn hard time of it. Their men died of thirst, sickness and Indian attacks, and most of the casualties came right along there. So they called it Valle de la Jornada del Muerto . . . Valley of the Journey of Death. So we lost three F-86's, half a battalion of tanks and a full trainload of innocent bystanders, not to mention White Sands Proving Grounds—and those alpha-centaurs or whatever they were lost most of their invading force. Jornada del Muerto . . . Good name, don't you think?"

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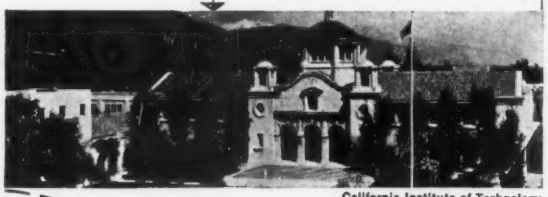

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from the editor's notebook

Technology and mechanical know-how alone will not save a nation . . . It will not even save the individual. There must be cooperation; between nation and nation; between equal and equal; cooperation between leader and those led. Attention must be paid to technical studies, to be sure, but the human studies must not be neglected. Leaders require today, as ever, a well rounded personality; not only must they be technically competent . . . they must know how to work with others, how to guide others, how to accept ideas from others, and how to cooperate with others.

We are fortunate, at M.I.T., to have at our disposal the materials for a full technical education. In addition to our formal departments, there is a vast student activity program. There is no emphasis on a particular sport or activity, for they are all important. Each activity enables its members to work together to attain an established mission. Whether the mission is to win a contest or develop a skill, cooperation is essential. By participating in an activity, the student enjoys that scarce quality about M.I.T., relaxation; not only that, but he is taking an extra course . . . a course in "Human Engineering."

Life will be easier at Tech, and more rewarding if you cooperate with your fellow students and faculty. Help the other fellow; once you grasp a concept do not let it stagnate in your mind, teach it to a friend. In addition to clarifying the idea in your mind, while doing this, you will have helped to spread knowledge. Some new concepts you undoubtedly will find difficult . . . ask someone to help you. The time saved clarifying fundamentals at the outset of a course may mean the difference between success or failure later. Remember this.

It is readily observed that the favorite evening pastime of students is, without doubt, the "bull-session." The topics run the gamut; physics, women, science fiction, examinations, instructor personality, restaurants, theatres, all the way to the M.I.T. soap-chocolate-burnt rubber atmosphere. These discussions are interesting; you will learn a lot from some, and you will find (when the clock rolls around to three) that they are time consuming. Bull-sessions are an integral part of the M.I.T. life . . . but they are not the whole. Consider, for a moment, that when you leave school your time will be worth approximately $10.00 per hour, and with this in mind proportion your present time judiciously.

Those of you who have ground through the above four paragraphs and are nevertheless somewhat above a somnolent state, deserve a coke or beer. That is exactly what we at t.e.n. are offering you, in addition to an opportunity to learn more about M.I.T. and the research projects currently under way in our community. Drop down to our offices in the basement of the Walker Memorial for a talk along with a cool one. Take a close look at the opportunities we have to offer; there is one which will be advantageous to you, and to us. Activities are important and I think you will find ours enjoyable.

K. R. K.

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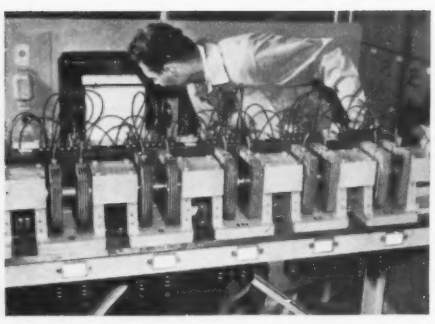

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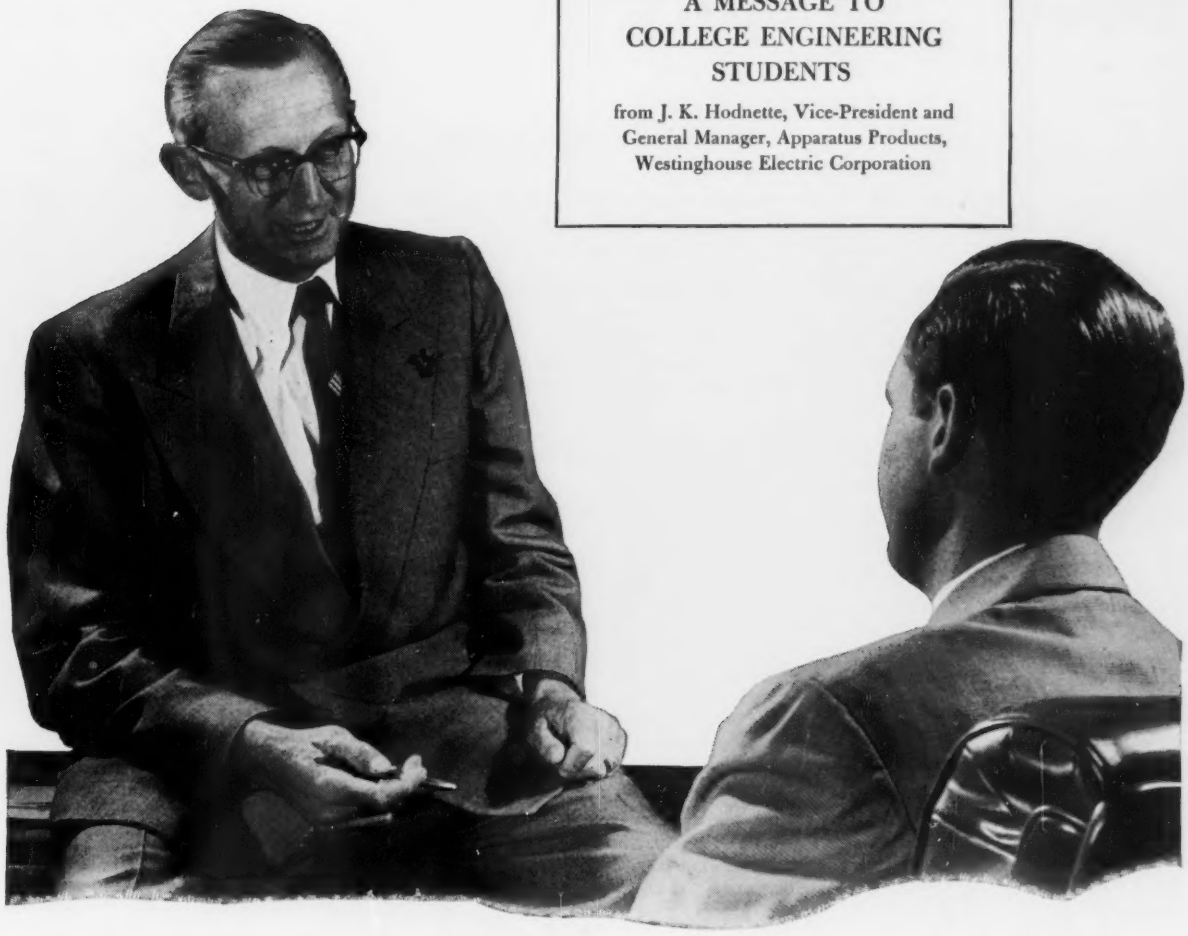
from J. K. Hodnette, Vice-President and General Manager, Apparatus Products, Westinghouse Electric Corporation



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flood frequency

By Emmanuel Papadakis, '56

This article is a discussion of one statistical method useful in the study of floods on streams having suitably long and exact records. The method to be discussed yields results in the form of the *probability* that a flood of a certain size will be exceeded in any year.

It is useful to know the flow frequency, that is, the probability distribution of flood flows, of various streams for several reasons. For instance, in the design of levees and other flood protection works, it is necessary to know the magnitude history of past floods. This knowledge is gained by the use of frequency curves. According to the method to be explained, there is no flood, no matter how large, which has a zero probability. However, it would be uneconomical in the extreme to try to build local flood protection facilities to contain floods of extremely rare occurrence. Economic justification is of first importance. Is one justified in protecting against what is called the "maximum possible flood" (one not encountered to date) or must one design for a 1.0% or an 0.1% probable flood? The frequency curves can give the magnitude of a flood if its probability is specified. When the magnitude is known, then the height of a flood crest may be predicted from other charts or rating tables giving elevation versus flow at different points on streams. When the crest is known, then protection facilities may be designed to contain it.

The instantaneous maximum annual flood peaks or flood volumes (in volume per second) on streams, subject neither to regulation by dams or reservoirs nor to diversions by canals, follow a normal distribution curve.

A normal distribution is one in which the relative probability of occurrence of a quantity plotted on the x-axis of a graph follows the Gaussian probability bell curve on the y-axis. The Gaussian curve is given by $y = ce^{-h^2x^2}$ in which c and h are constants and e is the base of Naperian logarithms. Figure I is a graph of the Gaussian curve.

A more useful form of the equation is the following:

$$y = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\frac{x^2}{\sigma^2}}$$

In this form, σ is the Standard Deviation, a constant for each curve. It is a modulus of the variability of the values of x about x=O.

At this point we must define some quantities associated with the statistical analysis of flood frequencies.

Q=Stream flow in C.F.S. (cubic feet per second).
X=Log_{10}(Q)
n=Number of Instantaneous Maximum Annual Floods recorded.
(=Number of years of record.)
$\bar{X}$=The mean of the values of X. (= $\Sigma X/n$)
X=The mean of the values of X.
x=(X-$\bar{X}$). Since the values X are normally distributed about their mean $\bar{X}$, x will be normally distributed about x=O. x is the deviation of any X from the mean $\bar{X}$.

Figure I
The Gaussian Probability Bell Curve.

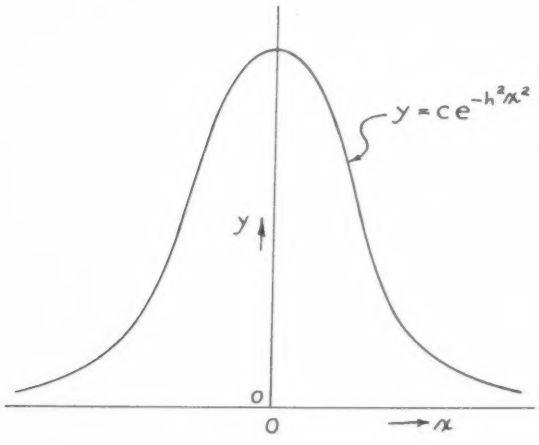
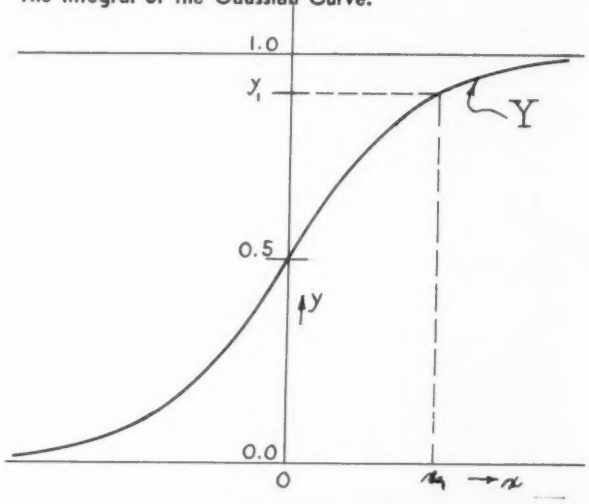


Figure II
The Integral of the Gaussian Curve.



$\left(\pm\sqrt{\frac{\sum (x)^2}{n-1}}\right)$ =the Standard Deviation of the values of x. It can be shown that at the points $x = \pm\sigma$ the Gaussian bell curve has points of inflection.

In a Gaussian bell curve, 68.27% of the area under the curve lies between $+\sigma$ and $-\sigma$. That is,

$$\int_{-\sigma}^{\sigma} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\frac{x^2}{\sigma^2}} dx = 0.6827$$

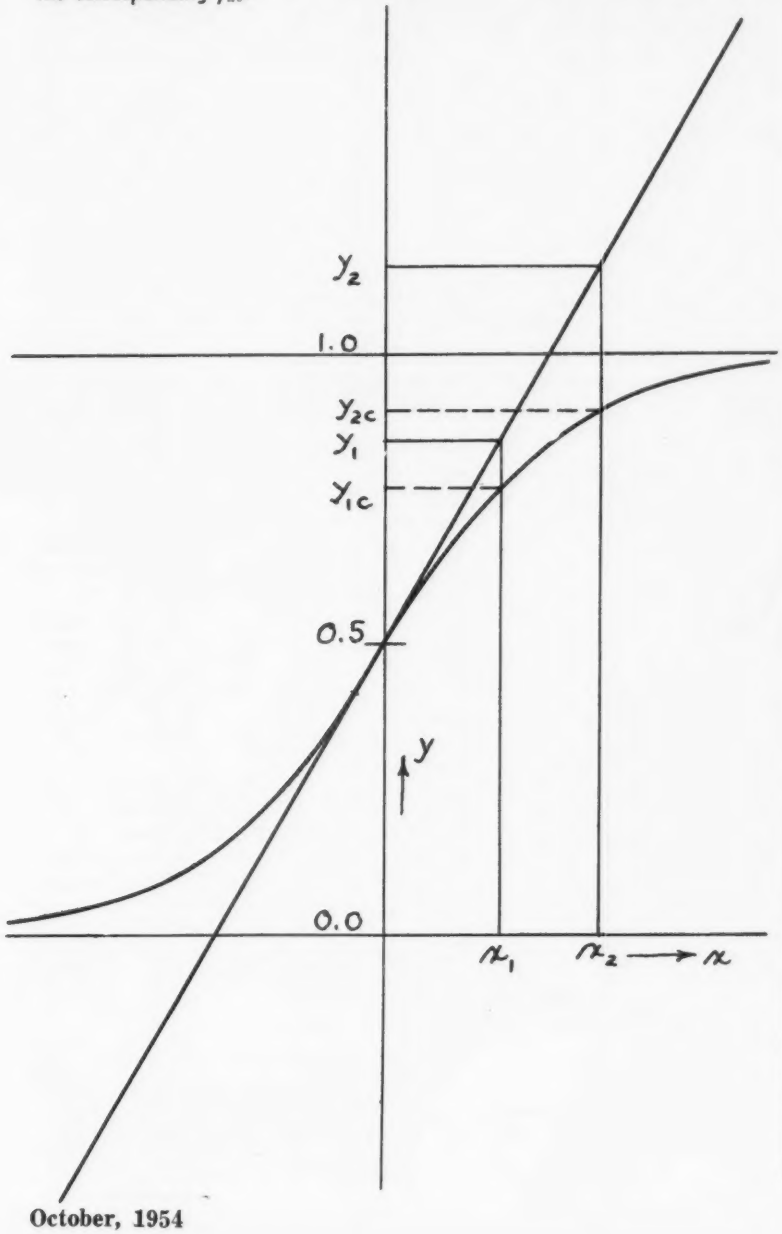
since

$$\int_{-\infty}^{\infty} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\frac{x^2}{\sigma^2}} dx = 1.0000\ldots$$

Since a probability is a pure number giving the fraction of all x having values between x, and x_2, the integral with respect to x will give the fraction of the x values within the limits of integration. The total probability of all x from $-\infty$ to $+\infty$ is one (1) since all the x values lie within that range.

Figure III

Diagram of the Procedure Used in Calibrating the Probability Graph Paper. For every x_n the corresponding y_n is given a calibration numerically equal to the corresponding y_{nc}.



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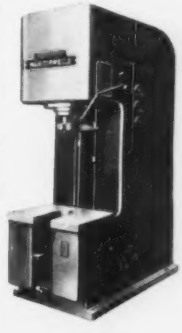

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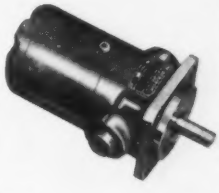

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TABLE I

X Value	% Of X Values Lower	% Of X Values Higher % Probability of Exceedence	Probability of Exceedence
$\bar{X}$	50.00	50.00	0.50
$\bar{X}-\sigma$	15.86	84.14	0.8414
$\bar{X}+\sigma$	84.14	15.86	0.8414

In any Gaussian bell curve, then, 68.27% of the x values lie between σ and $-\sigma$. Since the bell curve is symmetrical about the line x=O, half of the 68.27% or 34.14% of the x values must lie between $-\sigma$ and O and 34.14% between O and $+\sigma$.

It is inconvenient to plot a bell curve even if the x values and y values are given. There is no ready means of comparing the plotted curve with a standard bell curve. However, one can take the integral of the curve with respect to x,

$$Y = \int_{-\infty}^{x} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\frac{x^2}{\sigma^2}} dx$$

This will be a curve with the appearance of a sloping S with a continuous positive first derivative. Y will be asymptotic to y=O and y=1. See Figure II.

The y-axis of the integral curve will show the fraction of the total population of x smaller than or equal to a given x_1. In this way any y_1 gives the probability that any x will be smaller than or equal to the corresponding x_1. Then $(1-y_1)$ is the probability that the corresponding x_1 will be equalled or exceeded. The quantity $(1-y_1)$ will be called the *probability of exceedence*.

If a normally distributed population of x is arranged in descending order of magnitude the values may be plotted on an integral graph to give the integral curve. The y-axis could be divided into equal segments of number n where n is the number of items in the population. Each item x could be plotted in the middle of its corresponding y interval. Beard gives the position of the first x in the array as $Y=(1-0.5\frac{1}{n})$; the last as $Y=0.5\frac{1}{n}$. The intermediate values are plotted at equal intervals between the two.

The integral curve is still not a convenient shape to use. However, there is graph paper on which the integral curve can be plotted as a straight line! The graph paper may be constructed as follows:

First of all, the stream flow whose deviation x from the mean log of peaks is zero (0) has a probability of exceedence of 0.5. As can be seen in Figure II, this point (0, 0.5) is a point of inflection and a point of maximum slope of the integral curve. It is convenient to make a new reference

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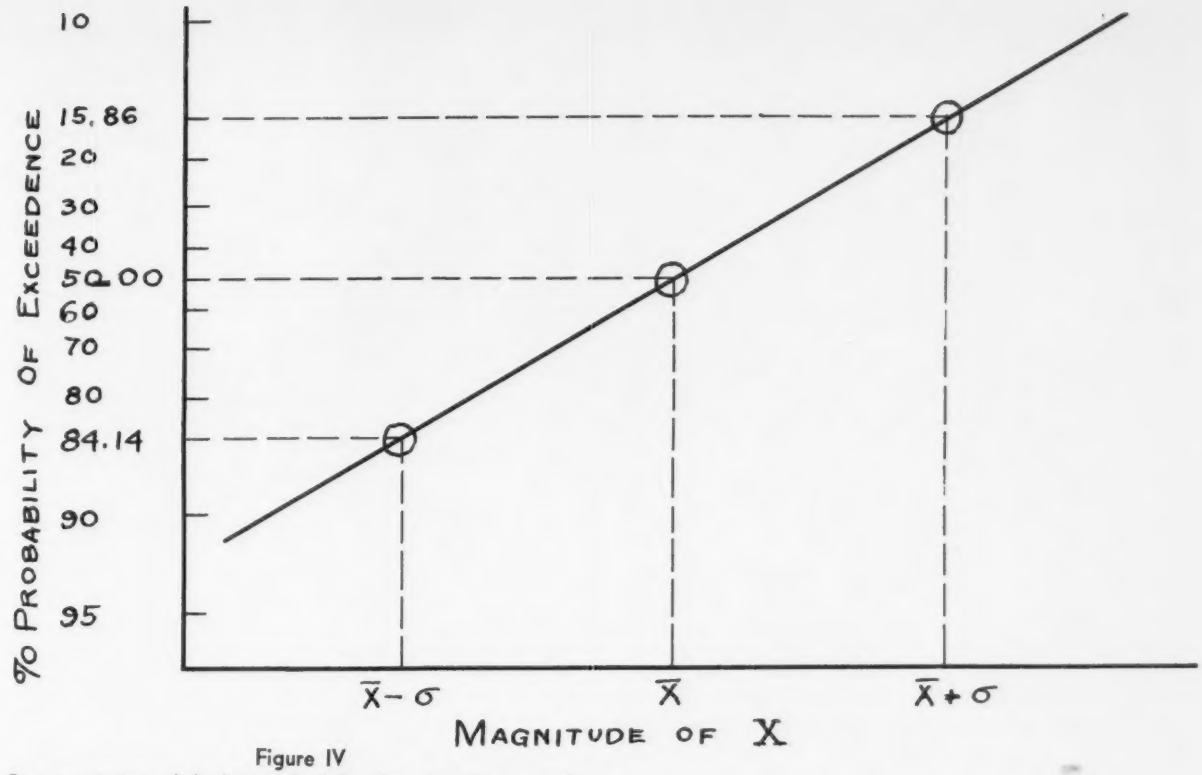
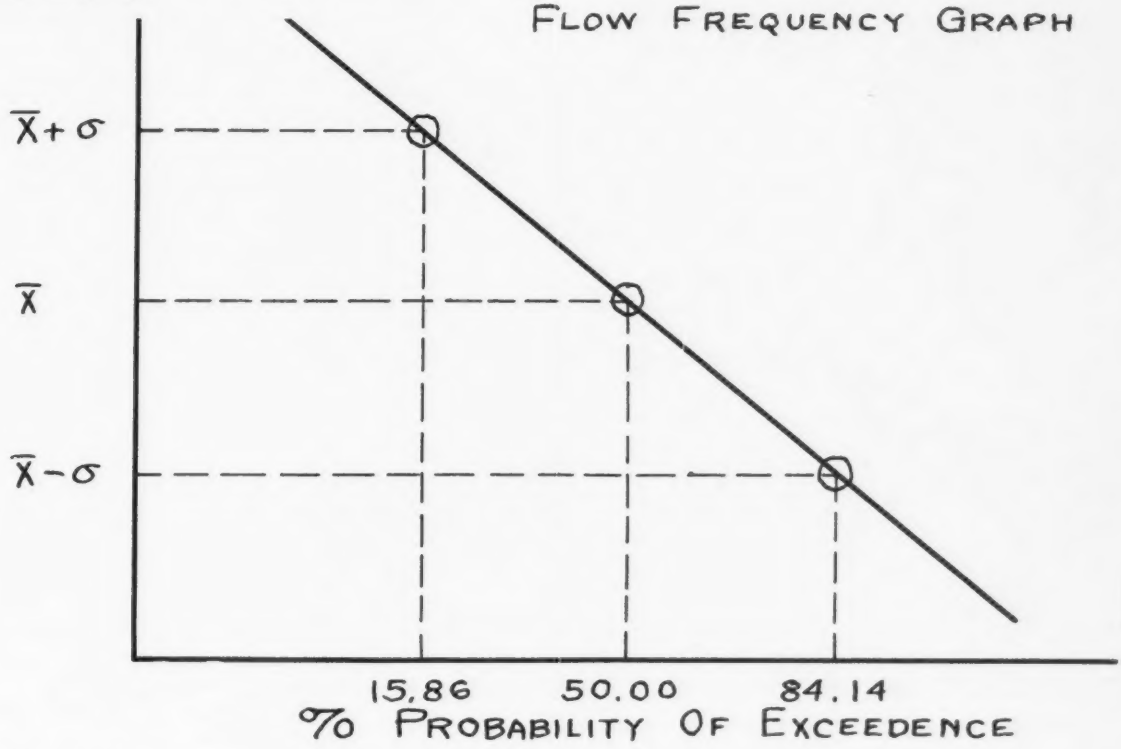


Figure IV

Representation of the Integral of the Gaussian Curve on the Calibrated Probability Graph Paper.

Figure V

Representation of the Integral of the Gaussian Curve on the Standard Probability Graph Paper. Such a curve is called a Flow Frequency.



system with this point as the origin. For the present the point will retain the designation (0, 0.5).

To make the slanted S integral curve plot as a straight line, the y-coordinates of the graph must be expanded symmetrically about the line y=0.5.

As an example let us say that we want the straight line plot to be coincident with the slope of the integral curve at (0, 0.5). Finding the slope,

$$Y = \int_{-\infty}^{x} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\frac{x^2}{\sigma^2}} dx$$

$$\left[\frac{dY}{dx}\right]_{x=0} = \frac{1}{\sigma\sqrt{2\pi}} e^{0} = \frac{1}{\sigma\sqrt{2\pi}}$$

Our line will be $y = \frac{x}{\sigma\sqrt{2\pi}} + 0.5$

This line passes through (0, 0.5) and has the slope of the tangent to the integral curve at that point.

If x were allowed to vary through all real values (as it must), y would vary from $-\infty$ to $+\infty$.

To calibrate the graph paper, we plot the straight line as though this were possible. However, the calibration of the y-axis must vary only from 0 to 1 so that the line can represent the integral curve. For an x_1 on x the graphical y-distance will be

$$y_1 = \frac{x_1}{\sigma\sqrt{2\pi}} + 0.5$$

For the same point (x_1, y_1) the calibrated value on the y-axis will be

$$y_{1c} = \int_{-\infty}^{x_1} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\frac{x^2}{\sigma^2}} dx$$

Thus, any point on the straight line will be given a y-coordinate numerically equal to the y-coordinate of the point on the integral curve having the same x. See Figure III.

It is immaterial whether the tangent to the integral curve at (0, 0.5) is used as the base line for calibrating the graph paper or not. Any straight line of finite positive slope passing through (0,0.5) may be used.

Once the graph paper is constructed, a curve with any σ can be plotted on it as a straight line. As shown, the y-coordinate will give the fraction of x values from the statistical population which are smaller than or equal to a given x value. The quantity (1-y) is called the *probability of exceedence* of a given x and gives the probability that that x will be equalled or exceeded.

To plot the line for any population of X values, one must find X, x=(X-X), and σ, the Standard Deviation. As mentioned previously, 34.14% of the x values lie between $-\sigma$ and σ, and 34.14% lie between 0 and $+\sigma$. The distribution is symmetrical about x=0 or X=X. Hence we know several things about three X values, $\overline{X}-\sigma$, $\overline{X}$, and $\overline{X}+\sigma$. This is shown in Table I, and Figures IV and V.

The empirical X values from which $\overline{X}$ and σ are calculated may be plotted on the same graph using the plotting positions alluded to earlier. The points found will not follow the theoretical curve perfectly, however. The goodness of fit of these points to the line gives an indication as to the truth of the statement that the common logs of the maximum instantaneous annual flood peaks or flood volumes are normally distributed about the mean of these logs. Since the curve is a straight line its quality is very easy to check. The normal distribution is a first approximation, and usually an excellent one, to the true distribution of the flows on streams. There are precise statistical methods available to check the quality of the approximation and to indicate the nature of the deviations if such seems necessary.

The statistics derived from the frequency analysis of streams can be correlated with other statistics such as those related to topography, rainfall, areas of the drainage basins of the streams, and the flow of streams in adjacent basins. With the application of digital computers to the job of correlation analysis, accurate quantitative predictions of flood flows and volumes will be possible and the optimum operating plans for flood protection systems such as the dams in the Missouri River Basin could be easily devised. The work of correlation, of applying computers to the problems outlined, and of making flow frequency studies of the tributaries of the Missouri River is being done under the direction of the Missouri River Division of the U. S. Army Corps of Engineers.

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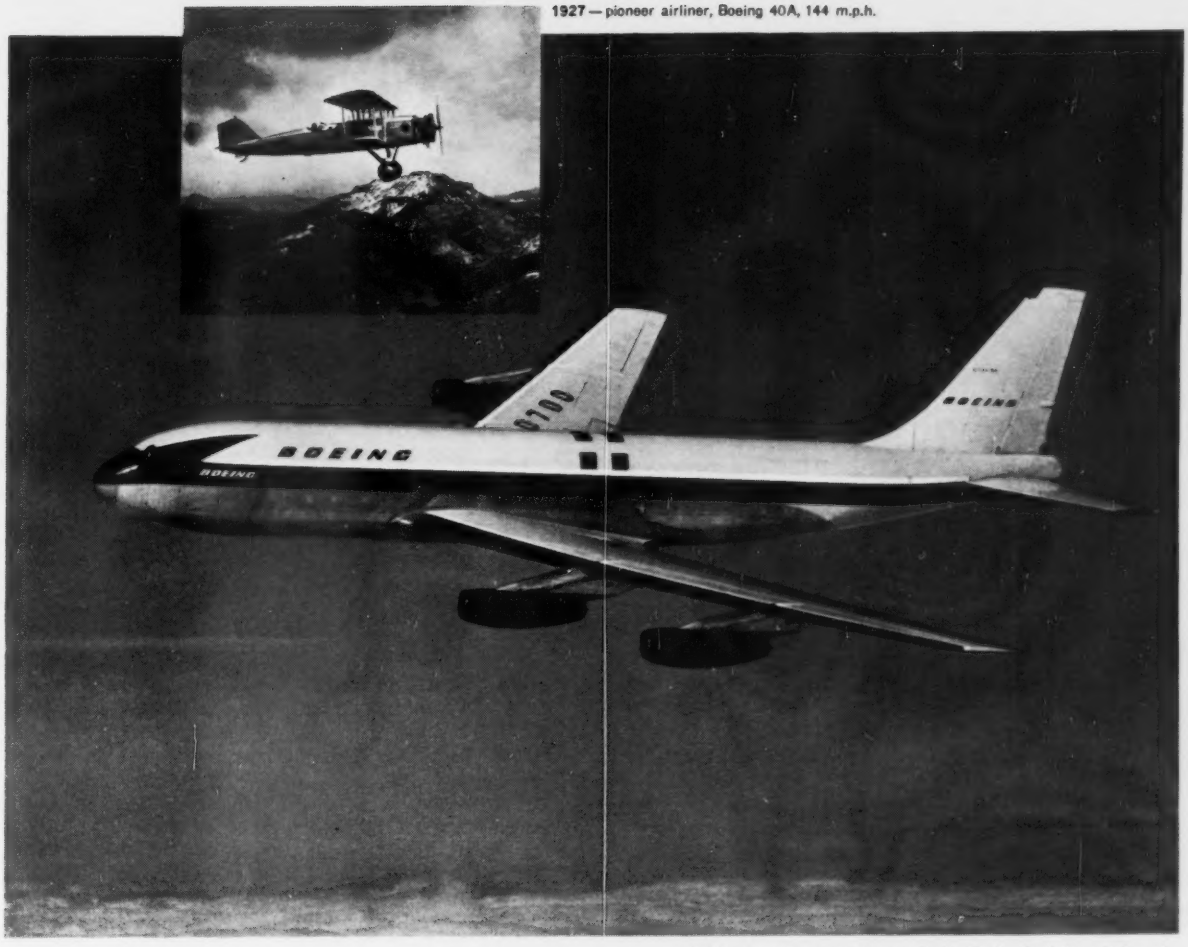

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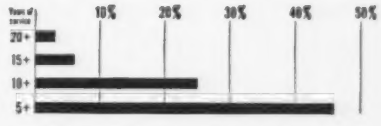

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massachusetts sport diving

By Peter Franklin, '57

Although you have probably seen the spreads in various popular magazines on the growing sport of skindiving, or read such books as Cousteau's *Silent World* or *Manta* or *Men and Sharks* by Hass, and although you may have seen such movies (the previews anyway) as *The Frogmen* or *The Creature from the Black Lagoon*, you will probably be surprised to learn that there is a great deal of sport diving activity here at Tech and in the surrounding Boston area. There are any number of students and lab employees who have built compressed air, self-contained, diving lungs using the high pressure oxygen demand regulator as described in the June '53 issue of *Popular Science*.

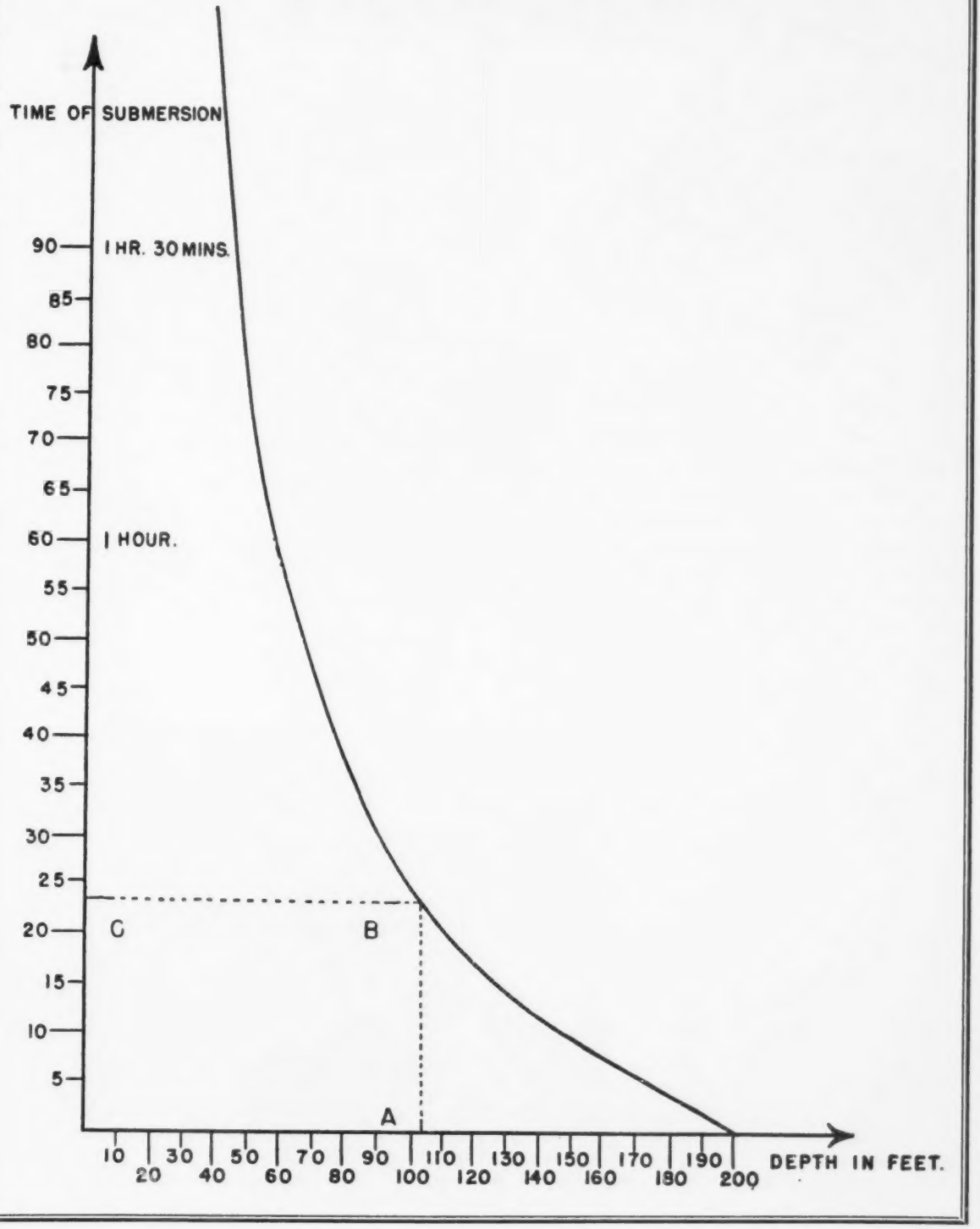
Aside from an ex-Underwater Demolition Team member, the author of a popular book on sport diving, and a graduate student who has designed and is preparing to produce his own compressed air diving unit, we have Dr. Edgerton, who has worked with Captain Cousteau on underwater photographic lighting equipment.

Several other undergraduates and I dive with a local club, the (Massachusetts) Amphibs. Due to the temperature of the sea in this area, the prospective Massachusetts diver generally finds it necessary to purchase considerably more than a hundred dollar's worth of equipment. The rugged type may find that he can endure the early fall and late spring water insulated perhaps with a tight-fitting cloth "wet-suit", but generally speaking, and certainly for year-round diving, more effective protection is necessary. Available on the market are a number of different dry and wet sport suits. The dry suits are generally made of a sheet rubber with a provision for neck, waist, front, or back entry and sealing around the wrists and face. The wet suits, which certainly have a limitation as to the temperature of the water in which they can be used, are composed of foam neoprene, the principle being that although water will penetrate, it receives body heat and cannot circulate. Now the economy-minded Massachusetts skindiver may hope to avoid any further expense, thinking to get along with his rubber suit, fins, mask and snorkel —and, indeed, he may. However, for effective free-diving it is necessary to super-oxygenate the blood by deep breathing, and it is often found that despite any suit, the rate of metabolism of the stored oxygen has increased to a quite discouraging extent. Now this is not always the case, but neither is it the only obstacle. Almost without exception a dry suit covers the head including, unfortunately, the ears. As most people are aware who have ever attempted to swim underwater, the Eustachian tubes, running to the middle ear, are equipped with one-way valves, which must be opened if the ear drum is not to give great pain or even puncture. There are a number of procedures for performing this equalization of pressure. However, it occasionally happens that the rubber suit will support the increasing pressure as the diver descends making it impossible to equalize. Suddenly then, fifteen or twenty feet down, the rubber will collapse against the head, exposing the drum to an unbearable pressure. The only solution to this problem, other than removal of the ear drums, is to carry one's air supply with one and to descend carefully and slowly.

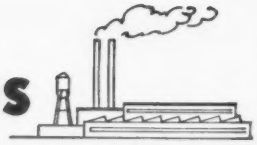
And thus we come to the interesting topic of self-contained div-

SAFETY CURVE

Indicating the Maximum Time Limit for Various Depths Permitting Return to Surface Without Special Precautions.



for all industries



Agricultural Equipment
Aircraft
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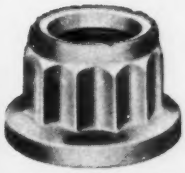
ing equipment, and we find the two major types, the pure oxygen rebreather, and the "throwaway" compressed air or oxygen unit. Most popular of all units in use today is the Cousteau-Gagnan Aqualung. The standard $160 unit consists of a single high pressure steel tank containing 70 cu. ft. of air and a 2150 psi, a two-stage gas regulator with an air reserve warning device. The high pressure stage of the gas regulator consists of a simple spring loaded pressure reduction mechanism, while the low pressure (100 psi) stage consists of a diaphram and rocker valve to deliver air as demanded at the pressure of the surrounding water. This unit is good for 100 minutes at the surface, 50 minutes at 30 feet, and 25 minutes at 100 feet. These units have been taken to a probable depth of 250 feet. Using a larger air supply men have gone to at least 297 feet, returning alive. However, the recommended maximum depth for amateur diving is approximately 140 feet, since beyond this point nitrogen under pressure will sometimes exhibit dangerous narcotic effects upon the diver's reasoning abilities and muscular coordination. If the diver finds himself not greatly affected by "the rapture of the depths," he may proceed at least to a depth of 300 feet. Here the partial pressure of the oxygen in the air the diver is breathing is approximately 30 psi. Oxygen under greater pressure may have a poisonous effect inducing convulsions and blackout. And, of course, at such depths as these, the air supply, which is being so rapidly exhausted, becomes a limiting factor. This is particularly true in view of the fact that the nitrogen under pressure will dissolve in the blood and body tissues and will form minute bubbles or emboli if caused to come out of solution too rapidly, in which case the diver is said to have caisson disease, characterized in the case of the aqualunger who would probably find it difficult to incur a fatal case, by mottling and itching of the skin, possible temporary deafness, partial temporary paralysis, and rather violent pain in the joints. Using a single tank Aqua-lung it is not possible to incur more than a slight case of vertigo, but when going deep with the double-tank block it is necessary to decompress, returning to the surface by stages. It is interesting to note that using a prepared helium-oxygen mixture dives have been made to 600 feet. Helium it seems has far less narcotic effect than nitrogen, in addition it is less soluble in the body tissues and has a higher rate of diffusion. Therefore, it is possible to decompress in one quarter to one third the time which would be required if air were used.

self-locking fasteners

Elastic Stop nuts

HEX NUT

SPLINE NUT



HIGH TENSILE NUT

CLINCH NUT

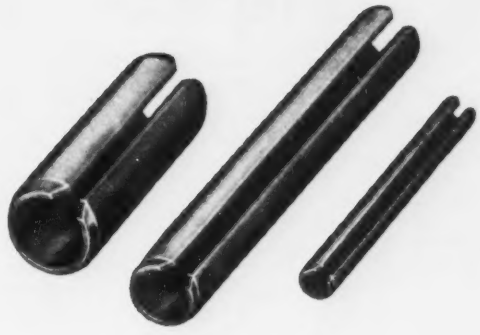
1200° F. HIGH-TEMP. NUT

GANG CHANNEL NUTS

FLOATING ANCHOR NUT

Every major aircraft now being assembled relies on the vibration-proof holding power of ELASTIC STOP nuts. Only ESNA manufactures a complete line of all types and sizes of self-locking nuts.

Rollpins



dia. from 1/16" to 1/2"

Rollpins are slotted, tubular steel, pressed-fit pins with chamfered ends. They drive easily into holes drilled to normal tolerances, compressing as driven. Extra assembly steps like hole reaming or peening are eliminated. Rollpins *lock* in place, yet are readily removed with a punch and may be reused.

Cut assembly costs by using Rollpins as set screws, positioning dowels, clevis or hinge pins. Specify them in place of straight, serrated, tapered or cotter type pins.

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AIR CONDITIONING

Frick Company recently completed the engineering and installation of a year 'round comfort air conditioning system for the new office annex of the Fairchild Aircraft plant in Hagerstown, Md., where they manufacture their famous C-119 Flying Boxcars.

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DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

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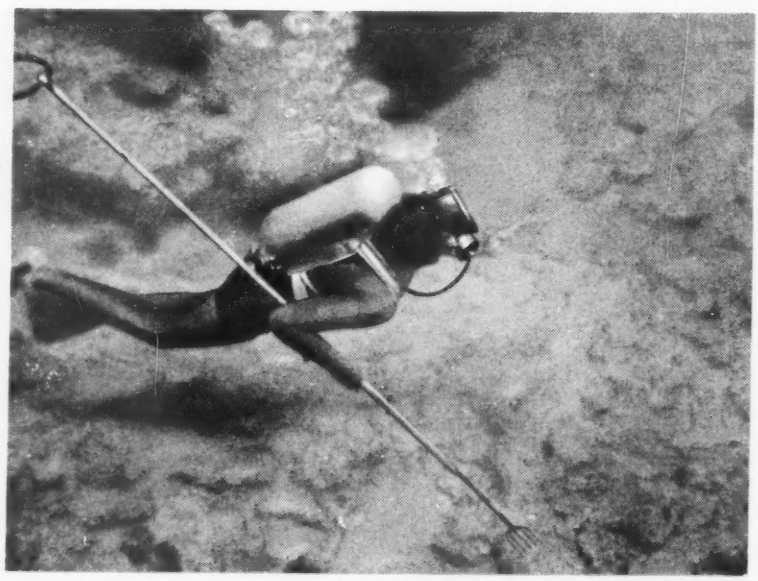
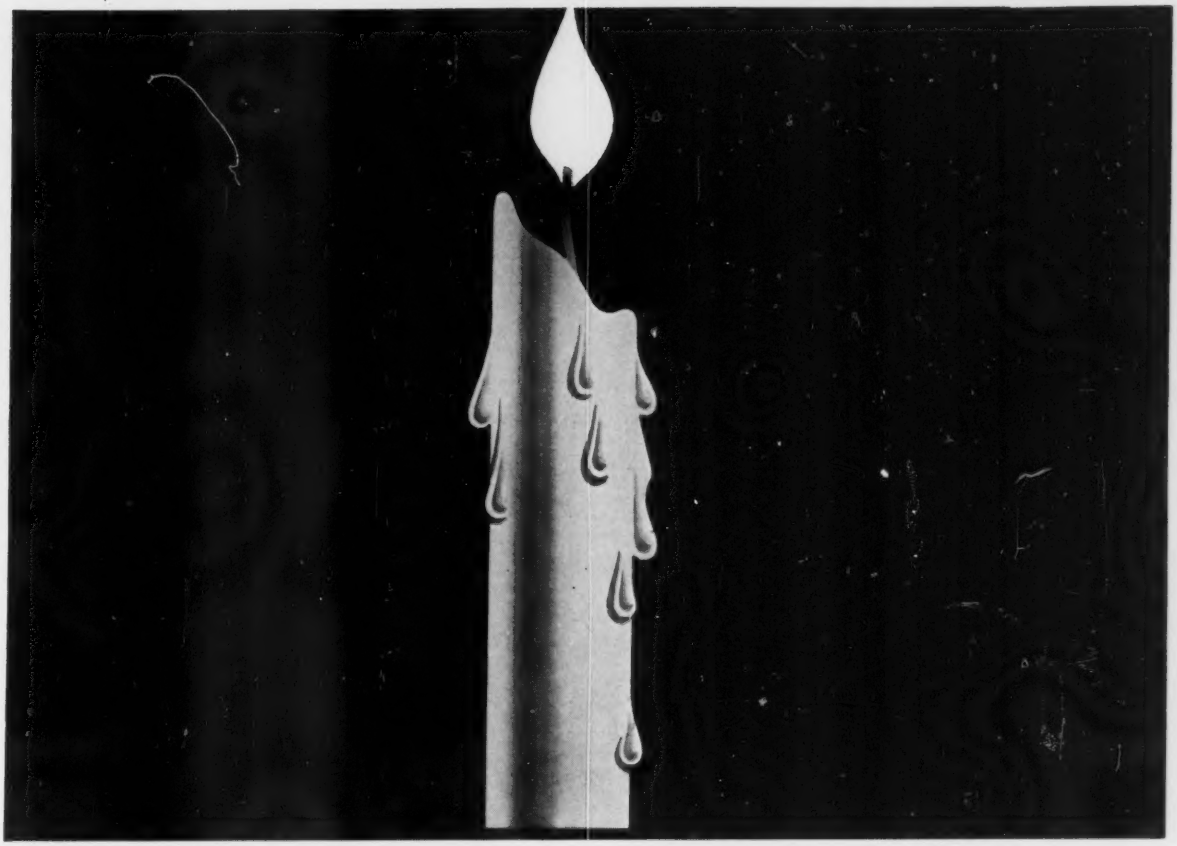
The oxygen rebreather, such as the No. 97 model produced by Desco of Milwaukee, is dangerous to use below 30 feet, although some people can take as much as a half hour of pure oxygen at 90 feet. The rebreather does have advantages in that it is not quite so bulky as the heavy air tank units, and oxygen is cheap and quite easy to obtain and very little is consumed anyway. On the other hand one must also keep a supply of a good, safe CO_2 water vapor absorbent. A very interesting piece of equipment is the deep water rebreather which introduces a tank of nitrogen-oxygen or helium-oxygen mixture in addition to the pure oxygen tank.

At each point where the partial pressure of the oxygen being breathed begins approaching 30 psi, the breathing bag is purged from the mixed gas tank.

The proof, if any is necessary for diving adherents, that skin diving has come of age is illustrated by the variety of auxiliary equipment now on the market. In addition to the breathing apparatus available, there are: hand, rubber, explosive, and gas propelled spears on the sporting shelves. Also available are: face masks, swim flippers, weight belts, and wrist compasses, along with other equipment for more specialized tasks.

The opportunities Massachusetts offers to the skindiver are great. From what I have seen of the deep water reefs off Key West, I should guess that the Massachusetts diver is indeed fortunate. Aside from the fact that skindiving combines some of the best attributes of many other sports, the unique attraction of diving as a sport is that the diver finds himself at home where other people would find themselves convulsed, suffocating, and paralyzed with cold. In addition to this the sea bottom is utterly different from the surface of the dry land and the colors underwater are never duplicated on the surface. All of this is true of the coral reef waters, but even more true of our Massachusetts coastal waters. Our rugged red and black granite hills scoured and carved by the sea are incomparably more impressive than sand and palm trees. The Atlantic's waters off these coasts seem darker and more ominous than the azure tropical seas. Underwater the colors are much more strikingly vivid. In short, there is much more of that atmosphere of other-worldliness. Then too, virtually any place you go for salt water diving in Florida, you find it necessary to take a boat in order to reach the good locations. Here we have our best diving immediately offshore. At Folly's Cove we have 80 feet 200 yards off shore, and at Magnolia, Mass., there is 110 feet a 1000 yards off shore. As drawbacks in comparison with warm water diving, we do not have the exceptional clarity which is found on the deep water reefs during extended periods of calm weather. In this one major aspect we are completely lacking. The major occupation of the warm water skin diver is spearfishing. We have some of this, and we have lobstering, but it is not the same; there is no comparison. We have no great grouper, no 600 pound jewfish, none of the big rays, the sharks and the barracudas. We have, however, the water, the equipment, and the inquisitive spirit.





WAX WORKS . . .

Until a few decades ago, the principal users of wax were the candlestick makers. Today's diversified demands for wax put it in the class of modern industrial miracles.

Go into a super-market . . . see how wax works in the packaging and protection of milk and dairy products, cereals, bake goods, frozen foods. Think of its use in drug and cosmetic products . . . cups, crayons and carbon paper . . . polishes, preservatives and paper matches . . . And the number of industrial applications defies accurate calculation.

TOO BIG FOR BEES . . .

The ancients knew the physical properties of wax . . . and bees supplied the raw material. What then spurred this century's growth in production to more than a half-million tons a year?

The answer lies partly in the petroleum industry's desire to find more profitable applications for one of its products . . . partly in the desire of other industries to improve their processes and products.

AMERICA WORKS LIKE THAT . . .

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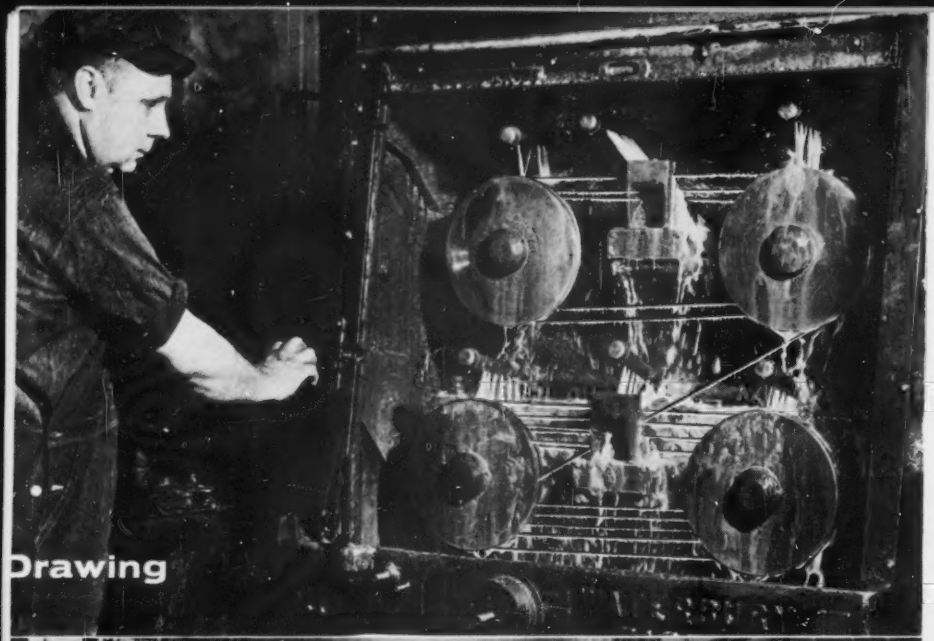
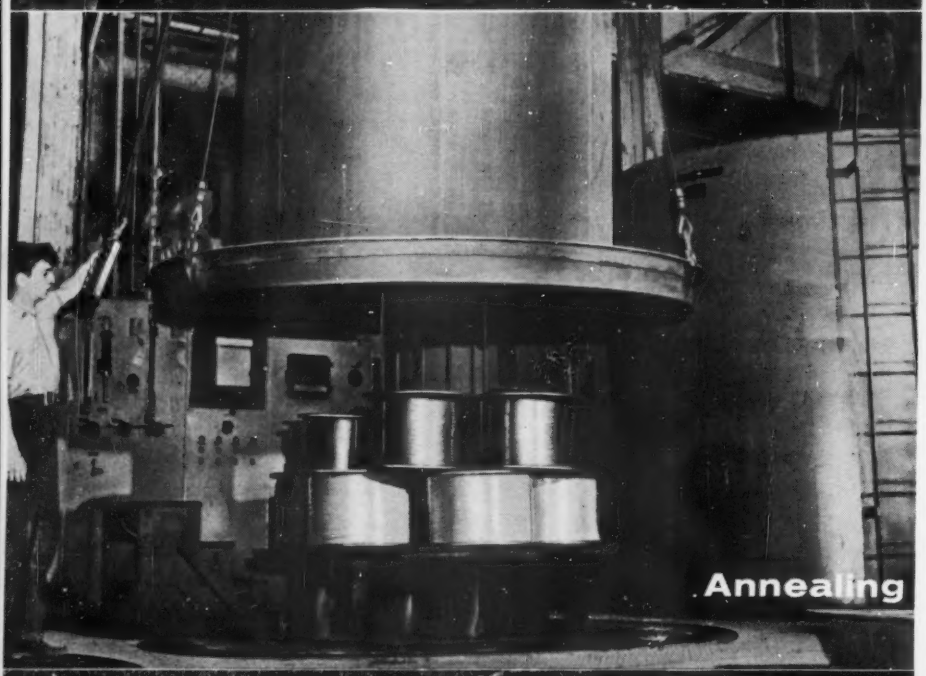
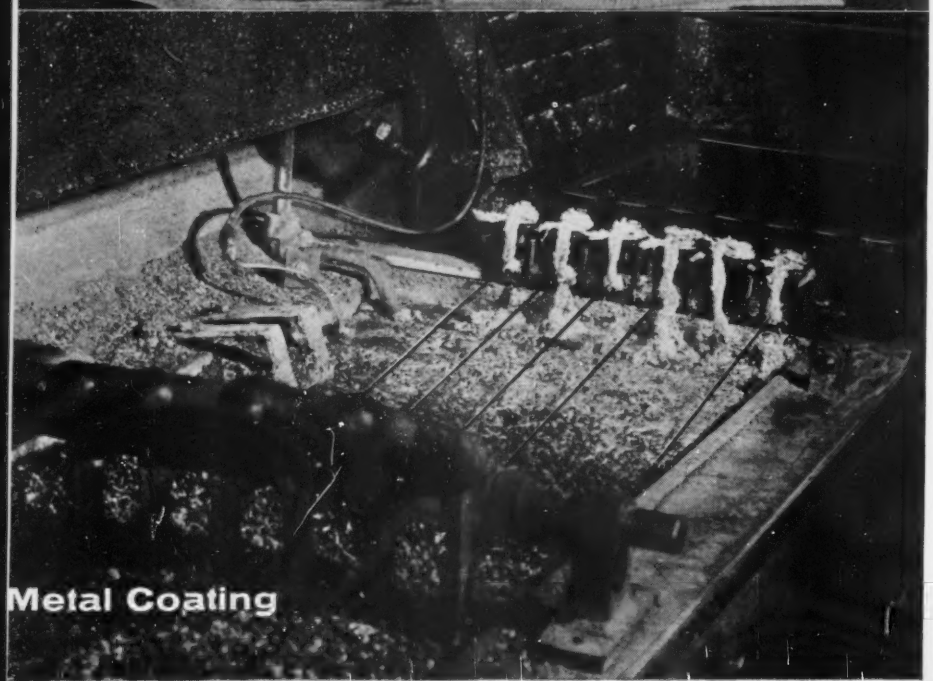


Drawing



Annealing



Metal Coating

The of

Electrical conductors for wires and cables are generally made from either aluminum or copper. Except as noted below under annealing and metal coating, essentially the same method is used in preparing electrical conductors from these metals.

Preparation of Wires

The metal, after purification at the refinery, is cast into billets about four inches square and about four feet long. For use in electrical conductors, this billet is reduced in cross-sectional area to produce the flexibility required in the finished wire or cable. For example, weatherproof wire for outside power distribution, where little flexibility is required, contains conductors that are solid or made of relatively few wires. For heater cord and welding cable, where excessive flexing in service occurs, the conductors are made up of a large number of small wires. Between these two extremes there is a wide variety of cable constructions requiring numerous sizes of wires.

The reduction in area of the billet is begun on the rolling mill where the billet is reduced to rods, the commercial sizes of which vary from about one-quarter to three-quarters inch in diameter. Rods are reduced to final wire sizes by drawing through a succession of dies of gradually decreasing diameter, the reduction in area per die or draft being about 30 per cent.

Drawing

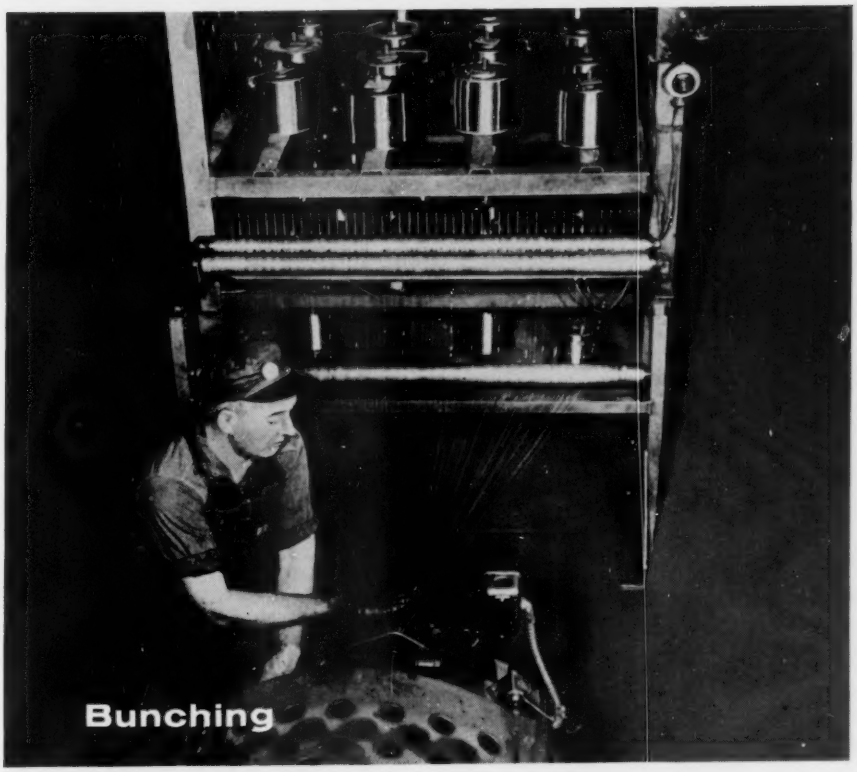
The drawing of wire increases its hardness and tensile strength and decreases its elongation and electrical conductivity. Since elongation determines the ability of a material to withstand repeated bending or flexing, it follows that the drawing of wire reduces its flexibility. Except where strength is important, as in weatherproof wires supported aerially, practically all electrical conductors should have greater flexibility and electrical conductivity than that provided by hard-drawn wire. Both flexibility and conductivity are improved by annealing hard-drawn wire.

Annealing

Annealing consists of subjecting the wire in coils or on spools to a temperature of about 650°F for about two hours. Large coils or spools may require a longer time and higher temperature. To prevent tarnishing during the annealing of copper wire, it is necessary to anneal in an inert (oxygen free) atmosphere. This precaution is not necessary in annealing aluminum wire. Annealing of hard-drawn wire increases its ultimate elongation about 2000 per cent and electrical conductivity about 3 per cent.

US RUBBER

preparation electrical conductors


Bunching

Metal Coating

Unprotected copper in contact with rubber insulation combines with sulphur in the insulation to form copper sulphide. This reduces the conductivity of the copper and makes it brittle and difficult to solder. Furthermore, copper in contact with rubber, accelerates the combination of rubber with oxygen and hence promotes the deterioration of rubber insulation. To prevent this mutually harmful action, copper for use in rubber-insulated wires and cables is protected with either a thin continuous coating of inert metal, such as tin, lead, or lead-tin alloy on the individual wires or a separator consisting of a wrap of threads or tape over the uncoated conductor.

Metal coating consists of passing the individual copper wires successively through (a) dilute hydrochloric acid, (b) molten metal or alloy, (c) a wiper, (d) a cooling bath and finally to a take-up reel. The hydrochloric acid cleans the surface of the copper insuring a perfect union between the copper and the coating metal and a complete coverage of the copper by the coating metal. The wiper removes the excess coating material and produces a smooth surface on the coated wire.

Metal coating or a separator is not required on aluminum conductors for rubber insulated cables since aluminum does not combine readily with sulphur and does not accelerate the deterioration of rubber.

Stranding of Conductors

As pointed out above, the purpose of wire drawing is to so reduce the cross-sectional area of the billet or rod that a conductor of the required flexibility can be produced. In addition to adequate flexibility, the conductor must also have sufficient cross-sectional area to provide the current carrying capacity and voltage drop required for a particular application. In general, the service conditions and current carrying capacity of wires and cables are such that conductors of greater flexibility than is obtained with a single wire (solid conductors) are required. Solid conductors are used generally only on sizes 6 Awg. and smaller conductors and then only for fixed (not portable) installations. Most conductors are, therefore, made up of more than one wire.

The formation of a conductor by bringing together the required number of wires is known as stranding, and the conductor thus formed is known as a stranded conductor. There are two fundamentally different types of stranding, namely, bunched stranding and concentric stranding. These differ in the manner in which the wires are assembled to form a conductor.

Bunched Stranding

In bunched stranding, the required number of wires are simply twisted together with no attempt being made to control their relative positions within the group. The length of the group requiring a complete turn of any one wire is known as length of lay of the strands. The length of lay varies widely with the number and size of the wires and the flexibility desired in the conductor.

Concentric Stranding

In concentric stranding the individual wires are laid up symmetrically in the form of a geometrically compact group. For example, six wires will lay snugly around one central wire, twelve wires will lay around a group of seven, etc. All of the wires are laid up around the same or a common center, hence the term "concentric stranding". The number of wires in the outer layer increases by six and the total number of wires in the assembly becomes 1, 7, 19, etc. The wires in any one layer are cabled or twisted around the central core with a definite length and direction of lay. The direction of lay of the wires is reversed in alternate layers to equalize the torsional forces resulting from twisting the wires about the central core. The length of lay depends on the size of the individual wires and the number of layers in the conductor.

Rope Stranding

A modification of concentric stranding known as rope stranding is used chiefly in the preparation of large flexible conductors for portable and welding cables. This differs from concentric stranding in that a group of wires, known as ropes, instead of individual wires, are laid up in a geometrically compact form of six around one, etc. These groups of wires may be either concentric or bunched stranded. This type of stranding makes possible building up a conductor with a greater number of wires than can be produced by concentric stranding on a machine with a given number of spools.

Other Strandings

Other types of conductor strandings, such as "sector-shape", "compact-strand" and "segmental" are used for special purposes to reduce conductor diameters and conductor losses.

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sound velocity measurement

By Rae Frank Stiening, '58

The experimental measurement of the velocity of sound has always presented the physicist with an intriguing problem.

The obvious and most direct method is best illustrated by the classic gun experiment. A gun is fired and a distant observer notes the time lag between the flash and the report. This will indicate directly the velocity of sound. Of course, an accurate measurement of velocity is impossible in this case.

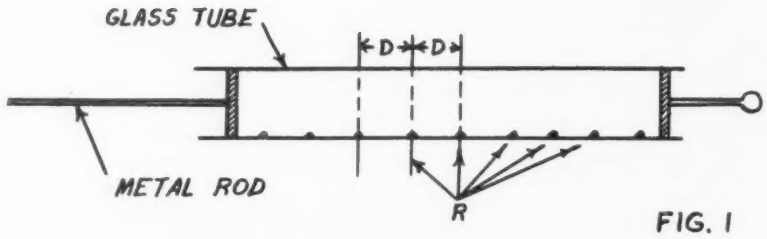


FIG. 1

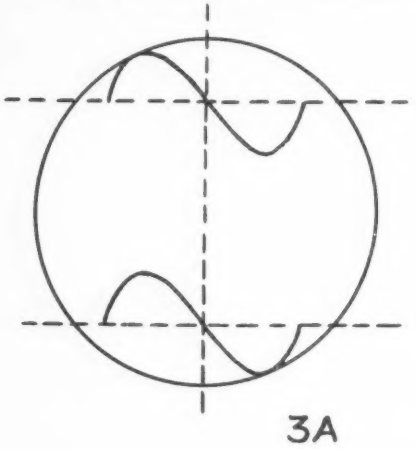
A better method for determining the velocity of sound was devised by the German physicist, August A. E. Kundt (1839-1894). Longitudinal vibrations are induced into a metal rod so as to produce stationary waves inside a gas filled glass tube.

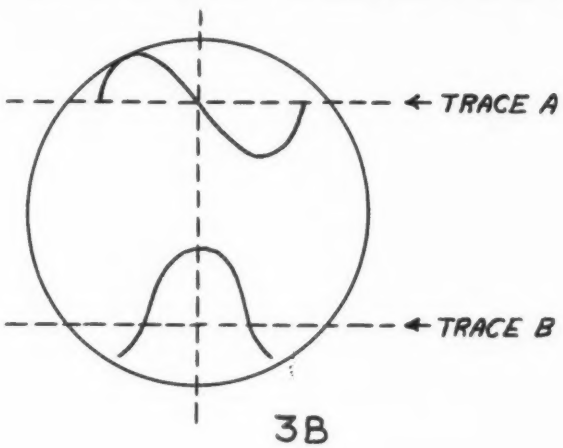
The rod is set into vibration and plunger P is adjusted until the cork filings spread over the interior of the tube show distinct differences in concentration. This will occur when the tube resonates. At the nodal points of the sound waves, the filings will be lumped together, and at the antinodes it will assume definite ridges. These ridges are illustrated by R (fig. 1). Of course a node will occur at D and P because the tube is a resonant system. The frequency of the sound induced into the rod is known and the average distance between the antinodes d can be measured. Therefore the velocity of sound can be calculated by the equation V 2Fd. F represents the frequency of the sound.

Although this method was a great step forward in the experimental derivation of the velocity of sound, it still had many limitations—the chief one being the difficulty incurred in accurately measuring the distance between the antinodes.

A modern method which has been devised is purely electronic and will permit a reasonably accurate measurement of velocity. It must be kept in mind that there are various mathematical processes by which velocity can be calculated. We are concerned here only with the experimental aspect of the problem.

Consider a loudspeaker placed at point A and a microphone constructed on a slide so that it is adjustable over distance AB. It is apparent that as the microphone is moved to various positions along the slide, the phase relationship between the sound at A and the sound entering the microphone will change. An oscilloscope provided with two vertical inputs by the addition of an electronic switch, is so connected to indicate this change in phase. One trace shows the sound at the loudspeaker while the other trace represents the sound at the microphone. If the microphone were placed directly in front of the loudspeaker, the waves indicated on the two traces would be in phase as is illustrated by 3A. If, however, the microphone was moved


3A



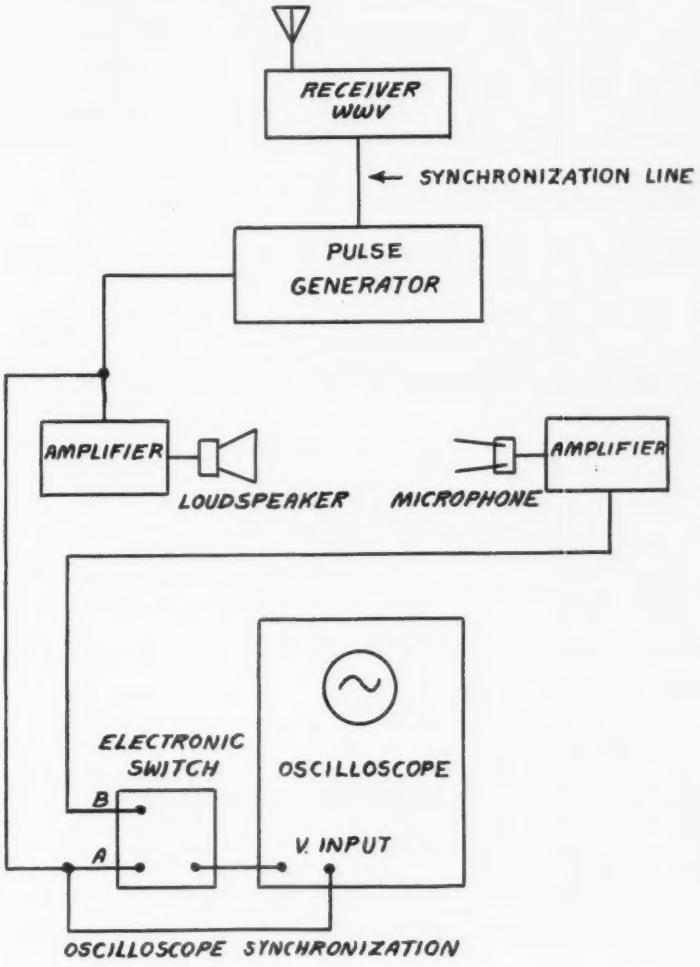
3B

away from the loudspeaker, the time required for sound to cover the distance between them would cause the phase relationship to change. Figure 3B is an example of what might occur. Trace A is connected to the loudspeaker and is thus constant, while trace B which is connected to the microphone, has changed its relative position (or phase). If the microphone were moved far enough away from the loudspeaker, the time lag would equal the period of frequency of the sound waves used, and the traces would again appear to be in phase. Let us assume that this occurs at point R. If the frequency of the sound is F cycles per second, it is obvious that 1/F is the time required for sound to travel from A to R. Therefore AR equals the wave length of the sound with frequency F. AR-F will indicate the distance that sound will travel in one second.

The necessity of having a very accurate sound source is naturally a problem. The Bureau of Standards radio station, WWV, provides a very accurate signal. WWV broadcasts make possible velocity measurements at 440 and 660 cycles per second. Either frequency is satisfactory because velocity is independent of frequency.

For purposes of illustration sine waves have been shown on the drawings. In the actual experiment a pulse generator generating very sharp, narrow pulses was used. This allowed a more accurate comparison of the two oscilloscope traces. The generator of course was synchronized to WWV. The Block diagram, figure 4, indicates the exact connections of the equipment used.

With this experiment it is possible to verify the mathematical calculation of the velocity of sound.



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The examples show how one designer has applied the principles of welded steel to a machine base. The sturdy box-type construction of the steel design eliminates weight because of steel's greater strength and rigidity. Considerable machining, cleaning and finishing of former castings has been eliminated. More modern in appearance, nevertheless, the steel design costs 15% less to produce.

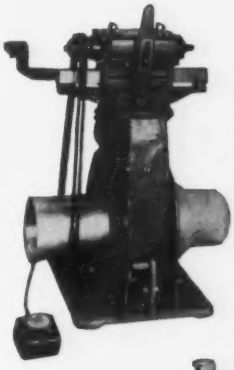

Fig. 1—Original Design *of wire straightening machine. Required considerable machining, cleaning and finishing prior to painting.*

Fig. 2—Welded Design *costs 15% less. Has improved appearance . . . better selling appeal. Tests show base has greater rigidity than in original construction.*

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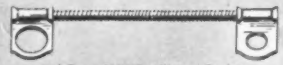
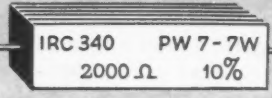


IRC Type AW Wire Wound Resistors

IRC Type BW Insulated Wire Wound Resistors

IRC 4-watt Insulated Power Wire Wounds



IRC 7 and 10 watt Power Wire Wounds

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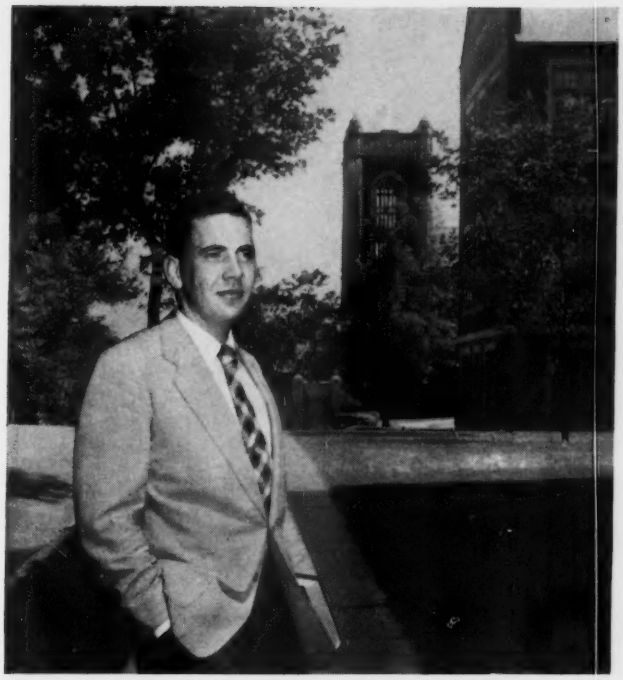

Donald W. Sundstrom received his B.S. degree in Chemical Engineering from Worcester Polytechnic Institute in 1953. He's currently studying for an M.S. degree and expects to receive it next year. Like other engineering students, he's asking a lot of searching questions before deciding on a permanent employer.

Don Sundstrom asks:

What are my chances for advancement in a big firm like Du Pont?

Gerald J. Risser, B.S. Chem. Eng., Univ. of Wisconsin (1937), is now assistant manager of the Engineering Service Division in Du Pont's Engineering Department, Wilmington, Delaware.

Jerry Risser answers:

I THINK I know exactly what's behind that question, Don, because the same thing crossed my mind when I first graduated and looked around for a job. That was about seventeen years ago, when the Du Pont Company was much smaller than it is today. And there's a large factor in the answer, Don, right there! The advancement and growth of any employee depends to a considerable degree on the advancement and growth of his employer. Promotion possibilities are bound to be good in an expanding organization like Du Pont.

Right now, for example, construction is in progress or planned for three new plants. That means many new opportunities for promotion for young engineers. And, in my experience, I have found it is a fundamental principle of Du Pont to promote from within the organization—on merit.

My own field, development work, is a natural for a young graduate, because it's one of the fundamental branches of engineering at Du Pont. There are complete new plants to design, novel equipment problems to work on, new processes to pioneer—all sorts of interesting work for a man who can meet a challenge. Many of the problems will involve cost studies—some will require evaluation in a pilot plant—but, in every case, they'll provide the satisfactions which come from working with people you like and respect.

All in all, Don, your chances of advancement on merit are mighty good at Du Pont!

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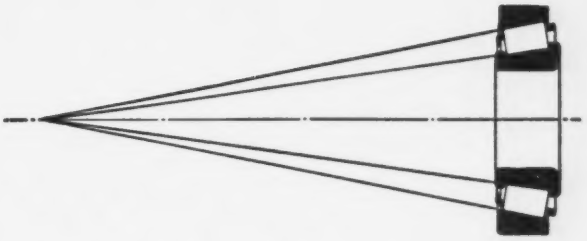

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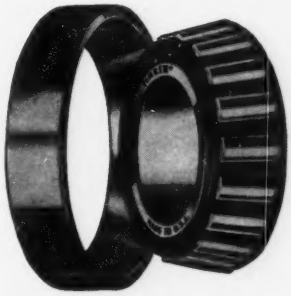

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NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL ◐ AND THRUST —◐— LOADS OR ANY COMBINATION —◉—

It is quite odd for me to write concerning live performances, one area where I cannot make up for a lack of musical knowledge by familiarity with virtues in the recording process. Nevertheless certain of the Tanglewood performances, as heard there and over WGBH, were too interesting for me to pass up comment at this time. Also, we know for a fact that RCA has projected a recording of Berlioz' REQUIEM MASS, the final Berkshire Festival performance gives us some clue as to what the recorded performance may be like.

First we may note that Dr. Munch was handicapped by a lack of the customary quality of choral he obtains from Prof. Woodworth's Harvard Glee Club and Radcliffe Choral Society. This latter group may have certain defects when compared to such professional groups as the Robert Shaw Choral and Westminster Choir; these latter groups are especially notable for their diction, all members pronounce all words identically, and this is a uniformity that cannot be expected of any college group. Nevertheless, Harvard-Radcliffe can be depended upon to transmit a conductor's conception of a work to the audience, and this the Festival Chorus was not capable of. Dr. Munch's interpretation suffered. Although the Festival Chorus is drawn from all students at the Berkshire Music Center and cannot be compared with a select group such as that of Harvard-Radcliffe, more rehearsal time would have helped. Indeed, during the rehearsal Dr. Munch gave clear indication of his frustration caused by the inadequate preparation of the chorus; for the first few sections he painstakingly corrected the chorus on each detail, then he seemed to give up and run through the remainder of the work.

What resulted at the performance was, therefore, unfair to Dr. Munch, although the choral work was better than attendance at the rehearsal would have indicated. The work has always been a very personal one for me, my conception of what it should sound like has been molded by the very fine performance on Columbia Records, of the professional Emile Passani Choir and Orchestra conducted by Jean Fournier. While actually reviewing the recording I'll add that this latter performance was recorded by Pathé in wartime France, and shows it by considerable treble distortion. The sound is filled with the marvelous reverberation of the St. Eustache Church where the work was first performed, however, and when this recording is played with sharp high frequency suppression it will, I'm sure, still sound better than the latest and finest RCA recording as represented by The Damnation of Faust. Unless the entire Boston Symphony and Harvard Glee Club and Radcliffe Choral Society is sent over to France, their recording will not be definitive as the older one was, although it may be well worth having for its own sake. Indeed, Munch showed a tendency to make the work more tenderer, by slower tempos in many sections, although in my opinion the Lacrymosa and the Hosannah choral fugue from the Sanctus movement suffered because of this. David Poleri will undoubtedly be the tenor on the RCA recording; his Tanglewood performance was very beautiful, done with more feeling, or to be unkind more operaticly and less subtly, than George Jouatte's on the Pathe-Columbia recordings.

Before leaving Dr. Munch we may mention that we expected the final performances of the Saint Saiens 3rd Symphony with Biggs as organist, Roussel's The Spider's Feast and The Ibert Flute Concerto with Doriot Anthony (now Mrs. Thomas Dwyer) as soloist; more surprising was a particularly excellent performance of the Mozart 31st Symphony. Here Dr. Munch emphasized the latent warmth of this "Paris" symphony, contrasting the superficial performance by Krips on London that I own; yet the orchestra seemed amazingly precise. Even more surprising was an affinity of Dr. Munch for Brahms in a really beautiful, well controlled performance of the Symphony number 2 in D. I've long considered the third movement of this symphony among the finest orchestral movements in existence; Munch sharpened the contrast between the delicate opening theme and the staccato faster second theme. In the first movement he paralleled the Monteux interpretation I've enjoyed for several years; in the last movement he paralleled the head of steam released in the much admired Toscanini interpretation.

I had heard much about Pierre Monteux' unusual interpretation of the Beethoven Fifth as heard at a Boston Symphony Sunday series concert last Spring and expected the fine performance heard (and taped) over a WGBH broadcast. It's a tense, almost neurotic, performance, with a substantially faster first movement than even Toscanini gave.

Also surprising was the very fine performance directed by Hugh Ross of the Haydn Lord Nelson Mass. We are used to fine performance on the Haydn Society recording, although poorly recorded, and it's impossible to place Ross's in that category. Nevertheless it's very significant that we do not have to go to Vienna to find a man who understands Haydn's purposes. Considering the performances of the Festival Chorus elsewhere, the success of the Haydn was even more surprising.

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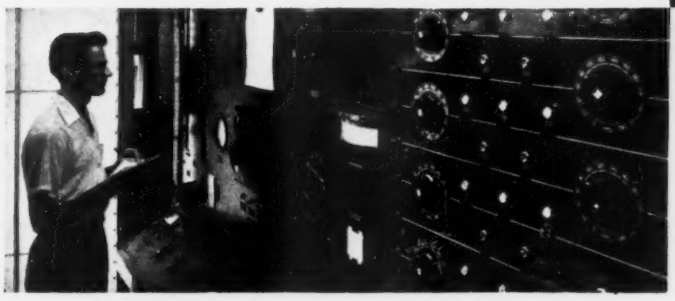
Carl Vrooman, icing tunnel group head, studies hot-air cyclic de-icing test on wing section of C-130 transport. The tunnel has a temperature range of −40° F. to +150° F. and maximum air speed of more than 270 mph.

New icing tunnel speeds thermodynamics research at Lockheed

Designed to meet a constantly increasing volume of thermodynamics work, Lockheed's new icing research tunnel now provides year 'round testing in meteorological environments normally found only in flight. It is the first icing research tunnel in private industry.

Lockheed thermodynamics scientists were formerly limited to testing time available at installations such as Mt. Washington. Now they are able to study in greater detail problems such as: thermal anti-icing; cyclic de-icing; various methods of ice removal; distribution of ice; rate of temperature changes in aircraft components; thermodynamic correlation between laboratory and flight testing; and development and calibration of special instrumentation.



C. H. Fish, design engineer assigned to the tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has refrigeration capacity of 100 tons, provides icing conditions of 0 to 4 grams per cubic meter, droplet sizes from 5 to 1000 microns.

Thermodynamicist Ed Dean monitors main control panel in picture at left. Temperature, air speed, water flow rate, air pressure and other variables can be regulated independently.

B. L. Messinger, department head, analyzes test results with Thermodynamics Engineer E. F. Versaw, right, and Thermodynamicist Tom Sedgwick, left. The report was in their hands *only two days* after it was decided to conduct the test.

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scratches and dirt

By Herbert B. Nichols

Ever try 35 mm. enlarging? Quite a few headaches are immediately apparent; the most minute imperfections of photographic technique and film become greatly exaggerated. Technique is the photographer's problem, but men are constantly working in the film industry on better film and gadgetry in order to make the processing work more mechanical. Recently Dr. C. Guy Suits of General Electric's Research Laboratory, an amateur photographer, developed a novel liquid which, when used in an unique film holder attached to an enlarger, minimizes the detrimental effects of scratches, dust, and finger prints.

Dr. Suits was frequently plagued (as are all miniature photography fans) by negatives perfect in every respect except for scratches that sometimes made them worthless for enlarging. For years, 35-mm enthusiasts have been forced to discard negatives in this condition, or put up with less-than-perfect results. Sometimes a subject can be rephotographed, but frequently this is not possible.

In making an ordinary photographic enlargement, light is passed through a negative and transmitted through a lens to form a magnified image on a sheet of photographic paper. After exposure, the paper is "developed" by usual chemical techniques to produce the end product—an enlarged print.

Attacking the problem scientifically, Dr. Suits found through analysis of film scratches that most of the troublesome damage occurred in the film base or in the gelatine overcoat, rather than in the silver image between.

Seeking a practical solution, Dr. Suits reasoned it might be possible to find a liquid that would come close to matching the physical and optical properties of film, one which could fill the "valleys" formed by scratches and eliminate the valley side-surfaces that scatter light. Some photographers have used glycerine for this purpose for many years, so the principle involved is not new. However, glycerine is very viscous and forms bubbles which oftentimes are worse than the scratches.

In addition to having the proper refractive index, the ideal fluid had to be nearly water-white, non-toxic, inert to film and emulsion, odorless, of proper viscosity, and possessing just the right vapor pressure—neither so low that it won't evaporate promptly when wiped off, nor so high that it vaporizes too quickly while in use.

The specifications added up to what seemed an impossible search for an artificial water-like medium. Water itself was rejected because it softens the film gelatine and is a source of additional difficulties. Glycerine was discarded because of its viscosity, the bubble problem, and the damage it does to negatives. Carbon tetrachloride had the proper refractive index and fulfilled other requirements, but evaporated too rapidly. It also fell down on toxicity. One cannot work with it for very long in a closed room.

Dr. Suits experimented with a long list of compounds that appeared hopeful, before his quest led eventually to an unusual member of a comparatively new family of compounds known as silicones. Certain silicone oils seemed to offer great promise. The most suitable of these he labeled "Refractasil." Early tests disclosed the liquid could be wiped off easily, leaving the negative not only dry but exceptionally clean.

The "exceptionally clean" introduced another thought. "Why not try the solution as a negative cleaner prior to producing enlargements?" Oily fingerprints are a frequent source of darkroom misery. So are dust particles that show up as blotchy, lighter-hued areas on finished enlargements. Surprisingly, Refractasil turned out to be an ideal cleaner, removing oily fingerprints like magic.

This seemed at first to be an "extra dividend" in so far as the original search was concerned, but it turned out that the detergent action is an essential attribute after all, otherwise objectionable shadows are introduced and the original purpose is defeated.

As for removing dust, the usual method calls for soft, camelshair brush. But this can produce a static electrical charge on the film (particularly in cold weather) which sometimes attracts more particles than are present before treatment. To provide for easy handling, Dr. Suits devised a special film-holder which can manage both a roll of 35-mm film and the liquid. As each frame passes across the center of the stage it is bathed thoroughly on both sides merely by squeezing a bulb. Dust particles are flushed out and disappear as effectively as finger marks.

When this invention is used, the exceptional precautions which traditionally surround the handling of 35-mm film are not necessary. No harm whatever is done by touching the negative with

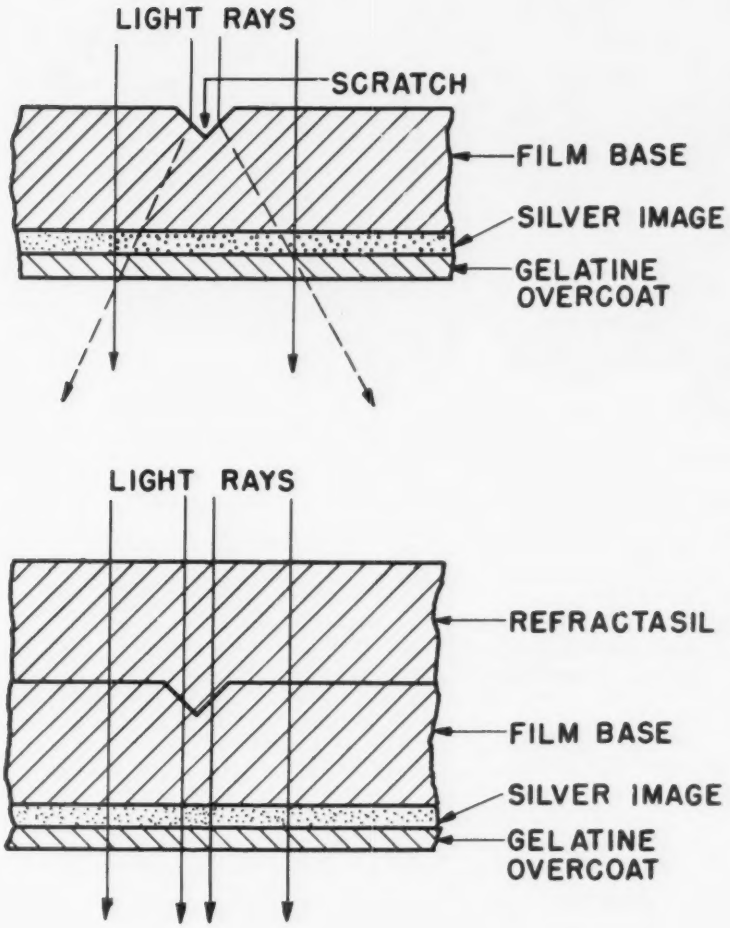

ILLUSTRATION SHOWING OPTICAL PATTERN OF LIGHT RAYS PASSING THROUGH 35 MM FILM WITHOUT AND WITH REFRACTASIL

the fingers or wiping it with tissue or chamois. Nor is it necessary to hold the film at its edges. In fact, any handling procedure which does not actually gouge the silver layer is quite satisfactory. If one prefers to store negatives in rolls, the scratches or cinch marks which generally come from such rough treatment do not harm whatever. Handling precautions for negatives are reduced to the same simple requirements of contact printing.

After the negative is removed from the printer, it should be wiped with chamois or hand tissue to remove excess liquid. This leaves it perfectly dry and clean.

The electrification phenomenon which prevents the removal of dust in air, is absent in the liquid. A small filter keeps the liquid clear so that it can

be used over and over again. Dirt and finger marks are so much more easily removed by Refractasil that no ordinary cleaning of any kind is necessary.

For the past several months, the designers of photographic equipment in the laboratories of Simmon Brothers, Inc., Long Island City, N. Y., have been working over the original Suits model. They believe the "Refractamatic 35" will be a practical, easy-to-use filmholder with a built-in circulating and filtering system, allowing professional or amateur photographers alike to turn out salon-type prints even though their negatives would once have been considered "hopelessly scratched." Simmon Brothers expect to be in production in the near future.

Refractasil is already in production and can be purchased soon by photographers who like to experiment. Its use decisively places fundamental limitations in print quality once again on the optical equipment, on resolution, and on graininess of the film.

Because scratches and dust have been so troublesome in the past, it has been common practice to employ a ground glass or flashed opal glass diffusing screen in enlargers as a means of partially coping with the problem. Such diffusion screens do greatly minimize the effect of small scratches, but only by reducing definition and contrast. When adopting the new liquid immersion technique, Dr. Suits advises using a condenser optical system without diffusion glass. The results are amazingly superior.

briefing the news

Adoption of International Nautical Mile

Since July 1, 1954, the National Bureau of Standards has used the International Nautical Mile in lieu of the U. S. Nautical Mile. This decision, replacing the U. S. nautical mile of 1853.248 meters (6080.20 feet) by the International Nautical Mile of 1852 meters (6076.10333....feet), confirms an official agreement between the Secretary of Commerce and the Secretary of Defense to use the International Nautical Mile within their respective departments.

The use of a mile derived from the length of a degree of the earth's meridian is very old. It is believed that the Chaldean astronomers determined the length of such a unit. Miles of this sort have been variously called meridian miles, geographical miles, sea miles, and nautical miles, and they have differed greatly in magnitude, some of the values providing 10, 12, 15, and 60 miles to a degree. The British and the U. S. nautical miles were each derived by taking 60 nautical miles per degree, but the values adopted were not the same. The nautical mile adopted by the British Admiralty equals 6080 British feet, while the U. S. nautical mile has had the adopted value of 1853.248 meters, from which the equivalent 6080.20 U. S. feet has been derived. The British foot is shorter than the U. S. foot by 1 part in 400,000, an amount which is of no importance in the ordinary transactions of everyday life but which is very important in precise measurements.

In 1929 the International Hydrographic Bureau obtained an agreement from a large number of countries to adopt a value of 1852 meters for the nautical mile, the unit thus defined to be called the International Nautical Mile. However, at the same time Great Britain, the U.S.S.R., and the United States did not accept this value, each country preferring to retain the nautical mile to which it had been accustomed.

Finally, in 1953 an informal group from the Department of Defense and the Department of Commerce considered a proposal for international standardization of abbreviations for the knot and the mile. At this meeting the general situation regarding the nautical mile was discussed, and the belief was expressed that a change from 1853.278 meters to 1852 meters would not affect nautical charts, the calibration of navigational instruments, or navigation. Because there seemed to be no sound reason why the International Nautical Mile should not be adopted in this country, the Departments of Commerce and Defense agreed to accept this value as of July 1, 1954, the announcement to be made by the National Bureau of Standards.

Identical directives, in the names of the two departments, have been mutually adopted. The Department of Commerce directive is as follows:

Adoption of International Nautical Mile

I. Purpose
To adopt the International Nautical Mile for use as a standard value within the Department of Commerce.

II. Implementation
After the effective date of this directive, the International Nautical Mile (1,852 meters, 6,076.10333....feet), shall be used within the Department of Commerce as the standard length of the nautical mile.

III. Effective Date
This directive is effective 1 July, 1954.

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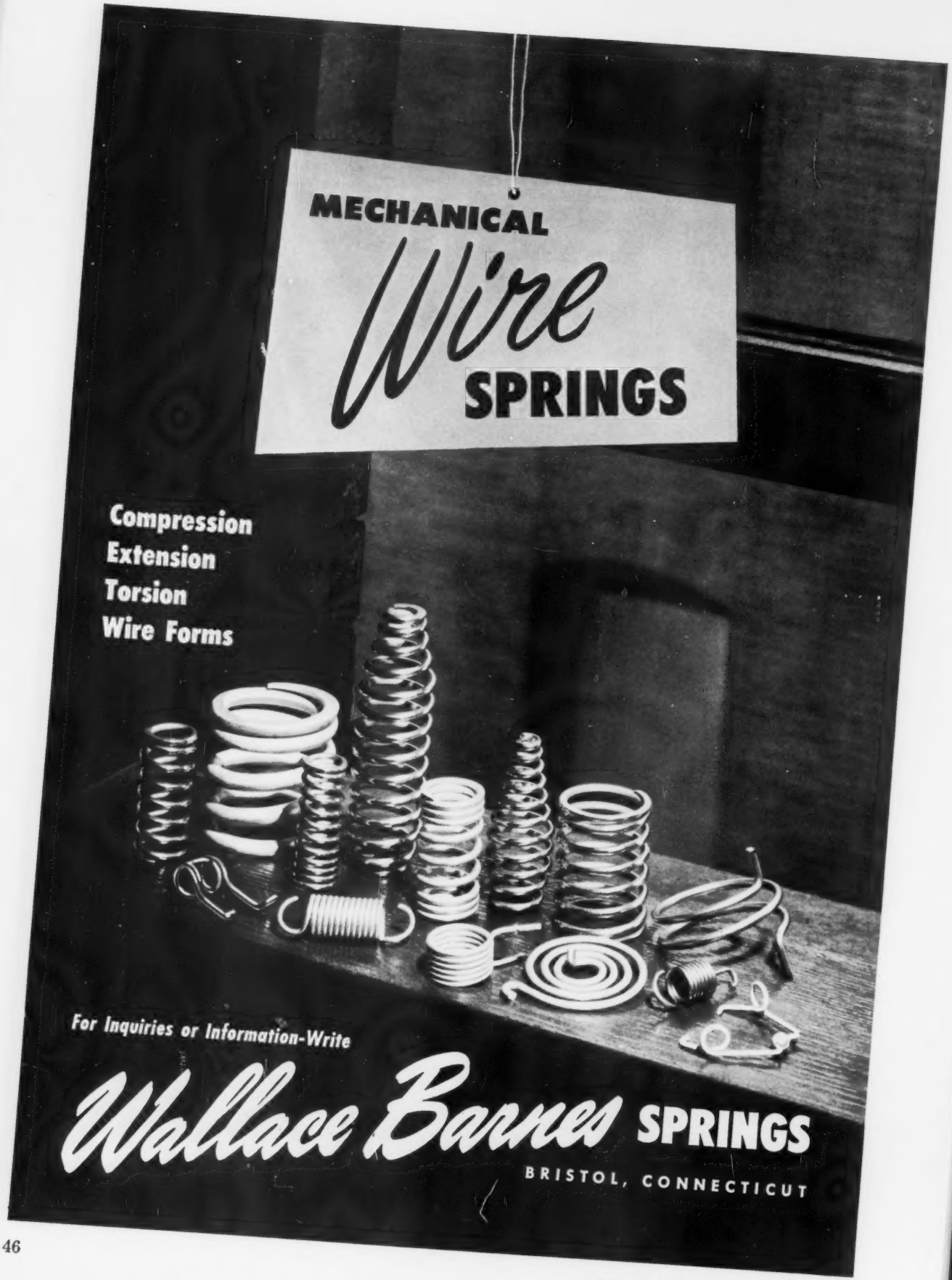
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"From my experience, I'd say, whether you're a freshman or a senior it will pay you to talk to an Allis-Chalmers representative now. You can't start planning your future too soon. And you can't plan starting at a better place, because Allis-Chalmers builds so many different products that you'll find any type of engineering activity you could possibly want right here."

Facts You Should Know About the ALLIS-CHALMERS Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

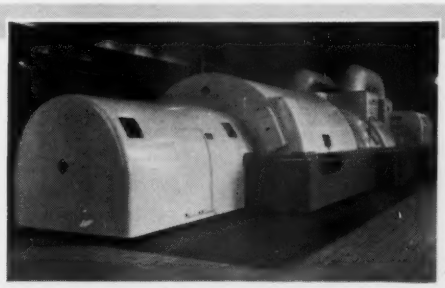
3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbogenerators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance of experienced, helpful superiors in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisc.



Steam turbines, condensers, transformers, switchgear, regulators are built for electric power industry.

Motors, control, *Texrope* V-belt drives—all by Allis-Chalmers are used throughout industry.

ALLIS-CHALMERS

C-5678

Texrope is an Allis-Chalmers trademark.

William R. Parlett, Cornell '48, Sets Sights on Executive Sales Job

BILL PARLETT has learned that helpful engineering suggestions promote good customer relations.

"Within the next ten years", says William R. Parlett, young Worthington Sales Engineer, "many of the officers of the corporation, district office sales managers and top salesmen will be retired.

"Appreciating the fact that someone must fill these jobs, our management is striving to develop capable leadership among the younger men of the corporation.

"As a prospective Worthington Sales Engineer, I received several months of classroom instruction by works managers, top sales personnel and application engineers at all of the Worthington plants. The background I obtained was a sound basis for further development and learning gained in one of the product sales divisions and then in a district sales office. After obtaining sufficient product knowledge and sales training, I was ready to sell directly to industry. As more important sales assignments are available, I feel I will progress in proportion to my own development and sales performance.

"As a Worthington salesman I contact a class of trade with which it is a pleasure to do business. The company's reputation is a key to a welcome reception by my customers.

"I have found that with Worthington you have job satisfaction, adequate compensation, and unlimited opportunity."

When you're thinking of a good job, think *high*—think *Worthington.*

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, N. J.

PHOTOGRAPHY AT WORK—No. 10 in a Kodak Series

Photography took a look

and a harvester got a stronger set of teeth

John Deere engineers, building a new beet harvester, wanted spring-tooth disposal wheels with long life. High-speed movies showed the way.

The disposal wheels on the new John Deere beet harvester moved faster than the eye could see.

So the engineers studied them in action, slowed down by the high-speed motion picture camera. A small difference in design resulted in extra-long life for the spring teeth.

Slowing down fast action is but one way photography helps product design and manufacture. With x-rays it searches out hidden faults in castings, welds, and assemblies. And by photographing cathode ray traces, it discloses the causes of improper operation. These are but a few of the ways photography saves time, reduces error, cuts costs and improves production.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. If you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Eastman Kodak Company
Rochester 4, N. Y.

With the high-speed motion picture camera, John Deere engineers took pictures of their spring-tooth wheels in action at 3000 a second. Projected at the standard 16 frames a second, the motion was studied, slowed down to almost 1/200 of its actual speed.

Kodak
TRADE-MARK

LOOKING AHEAD WITH GENERAL ELECTRIC

In the next 10 years there will be more opportunity in the electrical industry than in all the 75 years since Edison invented his lamp

THREE quarters of a century after the beginning of the Age of Light, you might think that the Age of Opportunity in electricity had pretty well ended.

Exactly the opposite is true.

So many promising new ideas are now being developed that at General Electric we expect to produce more in the next ten years than in all the previous 75 years of our existence. Electronics, home appliances, the development of peacetime uses for atomic energy—these are only some of the fields where great progress will be made.

We know you will share in this progress whatever your career. Perhaps you will contribute to it.

Thomas Edison invented his electric light at age 32.

Progress Is Our Most Important Product

GENERAL ELECTRIC